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CONFLICTS AND UNINTENDED CONSEQUENCES OF MOTOR FUEL STANDARDS

HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY AND ENVIRONMENT

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED TWELFTH CONGRESS

FIRST SESSION

WEDNESDAY, NOVEMBER 2, 2011

Serial No. 112–49

Printed for the use of the Committee on Science, Space, and Technology

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CONTENTS

Wednesday, November 2, 2011

	Page
Witness List	2
Hearing Charter	3

Opening Statements

Statement by Representative Andy Harris, Chairman, Subcommittee on Energy and Environment, Committee on Science, Space, and Technology, U.S. House of Representatives	8
Written Statement	9
Statement by Representative Brad Miller, Ranking Minority Member, Subcommittee on Energy and Environment, Committee on Science, Space, and Technology, U.S. House of Representatives	10
Written Statement	11

Witnesses:

Mr. Brendan Williams, Senior Director of Advocacy, National Petrochemical and Refiners' Association	
Oral Statement	13
Written Statement	14
Dr. Ingrid Burke, Director of the Haub School and Ruckelshaus Institute of Environment and National Resources, University of Wyoming; CoChair, National Research Council Committee on Economic and Environmental Impacts of Increasing Biofuels Production	
Oral Statement	20
Written Statement	22
Ms. Margo T. Oge, Director of the Office of Transportation and Air Quality, EPA	
Oral Statement	24
Written Statement	25
Dr. Jay Kesan, Professor and H. Ross and Helen Workman Research Scholar and Program Leader, Biofuel Law and Regulation Program, Energy Biosciences Institute, University of Illinois College of Law	
Oral Statement	29
Written Statement	31
Mr. Bob Greco, Group Director for Downstream and Industry Operations, American Petroleum Institute	
Oral Statement	35
Written Statement	36
Mr. David Hilbert, Thermodynamic Development Engineer, Mercury Marine	
Oral Statement	38
Written Statement	40
Mr. Jack Huttner, Executive Vice President, Commercial and Public Affairs, Gevo, Incorporated	
Oral Statement	41
Written Statement	43
Discussion	45

Page

Appendix 1: Answers to Post-Hearing Questions

Mr. Brendan Williams, Senior Director of Advocacy, National Petrochemical and Refiners' Association 58
Dr. Ingrid Burke, Director of the Haub School and Ruckelshaus Institute of Environment and National Resources, University of Wyoming; CoChair, National Research Council Committee on Economic and Environmental Impacts of Increasing Biofuels Production 61
Ms. Margo T. Oge, Director of the Office of Transportation and Air Quality, EPA 65
Dr. Jay Kesan, Professor and H. Ross and Helen Workman Research Scholar and Program Leader, Biofuel Law and Regulation Program, Energy Biosciences Institute, University of Illinois College of Law 73
Mr. Bob Greco, Group Director for Downstream and Industry Operations, American Petroleum Institute 80
Mr. David Hilbert, Thermodynamic Development Engineer, Mercury Marine .. 83
Mr. Jack Huttner, Executive Vice President, Commercial and Public Affairs, Gevo, Incorporated 87

Appendix 2: Additional Material for the Record

Letter to Chairman Andy Harris from Dr. Virginia H. Dale, Member, National Academies Biofuels Panel 95
Letter to Honorable Lisa P. Jackson, Adminstrator,Environmental Protection Agency, and White Paper, from Mitch Bainwol, President and CEO, Alliance of Automobile Manufacturers 97
Letter to Honorable Lisa P. Jackson, Adminstrator,Environmental Protection Agency, from Michael J. Stanton, President and CEO, Association of Global Automakers, Inc. 106
Letters Submitted to Honorable Lisa P. Jackson, Adminstrator, Environmental Protection Agency, from NESCHAUM, Ozone Transport Commission, and NACAA 109
Slide Presentation from Mr. David Hilbert, Thermodynamic Development Engineer, Mercury Marine 115
Presentation from Mr. David Hilbert, Thermodynamic Development Engineer, Mercury Marine 123
Gevo White Paper from the Testimony of Mr. Jack Huttner, Executive Vice President, Commercial and Public Affairs, Gevo, Incorporated 178
Potential Supply and Cost Impacts of Lower Sulfur, Lower RVP Gasoline, Prepared for the American Petroleum Institute, July 2011, by Baker and O'Brien Incorporated 194
Letters from Autobile Manufacturers to Honorable Lisa Jackson, Administrator, Environmental Protection Agency 213
Letters to Representative F. James Sensenbrenner, Jr., from Briggs & Stratton, Subaru, General Motors, and Mercury Marine 246
Association of International Automobile Manufacturers, Inc: Response to EPA Decision to Approve E15 Ethanol Fuel for 2001–2006 MY Vehicles 264
National Research Council of the National Academies: Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy ... 266
Letter from Chairman Ralph M. Hall to Honorable Lisa Jackson, Administrator, Environmental Protection Agency 296
Letter to Chairman Ralph M. Hall from Honorable Gina McCarthy, Assistant Administrator, Environmental Protection Agency 300

CONFLICTS AND UNINTENDED CONSEQUENCES OF MOTOR FUEL STANDARDS

WEDNESDAY, NOVEMBER 2, 2011

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENERGY AND ENVIRONMENT,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, DC.

The Subcommittee met, pursuant to call, at 2:38 p.m., in Room 2318 of the Rayburn House Office Building, Hon. Andy Harris [Chairman of the Subcommittee] presiding.

RALPH M. HALL, TEXAS
CHAIRMAN

EDDIE BERNICE JOHNSON, TEXAS
RANKING MEMBER

U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

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Conflicts and Unintended Consequences of Motor Fuel Standards

Wednesday, November 2, 2011
2:00 p.m. to 4:00 p.m.
2318 Rayburn House Office Building

Witnesses

Mr. Brendan Williams, Senior Director of Advocacy, National Petrochemical & Refiners Association

Dr. Ingrid Burke, Director, Haub School and Ruckelshaus Institute of Environment and Natural Resources, University of Wyoming, and Co-Chair, National Research Council Committee on Economic and Environmental Impacts of Increasing Biofuels Production

Ms. Margo Oge, Director, Office of Transportation and Air Quality, U.S. Environmental Protection Agency

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Mr. Bob Greco, Group Director, Downstream and Industry Operations, American Petroleum Institute

Mr. David Hilbert, Thermodynamic Development Engineer, Mercury Marine

Mr. Jack Huttner, Executive Vice President, Commercial and Public Affairs, Gevo, Inc.

HEARING CHARTER

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON ENERGY AND ENVIRONMENT
U.S. HOUSE OF REPRESENTATIVES

Conflicts and Unintended Consequences of Motor Fuel Standards

WEDNESDAY, NOVEMBER 2, 2011
2:00 P.M.—4:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

Purpose

On Wednesday, November 2, 2011, the Subcommittee on Energy and Environment of the Committee on Science, Space, and Technology will hold a hearing to examine motor fuel standards currently in place at the federal level and under consideration at the federal or State level; assess the scientific foundation for such standards; explore the inherent conflicts and unintended consequences of such standards; and question whether or not conflicts exist within the standards and the consequences of such effect the fungibility of, safe use of, and affordability of the United States motor fuel supply.

Witnesses

- **Mr. Brendan Williams**, Senior Director of Advocacy, National Petrochemical & Refiners Association.
- **Dr. Ingrid Burke**, Director, Haub School and Ruckelshaus Institute of Environment and Natural Resources, University of Wyoming, and Co-Chair, National Research Council Committee on Economic and Environmental Impacts of Increasing Biofuels Production.
- **Ms. Margo T. Oge**, Director, Office of Transportation and Air Quality, U.S. Environmental Protection Agency.
- **Dr. Jay Kesan**, Professor and H. Ross & Helen Workman Research Scholar and Program leader of the Biofuel Law & Regulation Program, Energy Biosciences Institute, University of Illinois College of Law.
- **Mr. Bob Greco**, Group Director, Downstream and Industry Operations, American Petroleum Institute.
- **Mr. David Hilbert**, Thermodynamic Development Engineer, Mercury Marine.
- **Mr. Jack Huttner**, Executive Vice President of Commercial and Public Affairs, Gevo, Inc.

Background

The Clean Air Act Amendments (CAAA) of 1970, 1977, and 1990 provided a number of regulatory tools to the EPA to reduce air pollution across the U.S. These tools can be divided into two types of approaches: ambient air quality standards and technology standards. Each approach attempts to address difficulties in attaining air quality improvements in a variety of ways, utilizing regulatory mechanisms to focus on stationary and mobile sources, pollution that travels across state lines, and technology limitations.

National Ambient Air Quality Standards

The regulatory scheme established by the CAAA of 1970 was based primarily on the concept of nationwide air quality goals and the development of individual State plans to meet those goals. EPA has identified six "criteria pollutants" for National Ambient Air Quality Standards (NAAQS): sulfur dioxide (SO_2), particulate matter

(PM),[1] nitrogen oxides (NO_2), carbon monoxide (CO), ozone (O_2), and lead (Pb). For each of these pollutants, EPA has set a primary standard at a level designed to protect the public health within an "adequate margin of safety." In addition, the statute allows EPA to set a secondary NAAQS to protect public welfare. At this point, EPA has not set secondary standards at different levels than the primary standards.

The standards themselves are not directly enforceable. Rather, NAAQS establish ceilings for concentrations of criteria pollutants in ambient air. States are required to develop their own State Implementation Plans (SIPs) that outline source-specific emission limitations (either stationary or mobile sources) in which the NAAQS will be "attained" or "maintained." SIPs must be approved by EPA. If EPA determines that a SIP will not be able to attain or maintain the NAAQS concentrations, EPA can require States to abide by a Federal Implementation Plan (FIP) until such time that the State develops an approved SIP.

Mobile Source Controls in the Clean Air Act

Title I of the CAAA directs the EPA to set NAAQS and standards for other harmful air pollutants and focuses on reducing pollution from stationary sources such as coal-fired power plants, refineries, and factories. However, emissions reductions from these sources are typically not sufficient for States to achieve the goals laid out in their SIPs, so additional tools are needed. Title II of the CAAA provides a framework for achieving further emissions reductions through regulation of mobile sources. Although separate titles, changes to Title I automatically impact implementation of Title II, and vice versa. For example, if EPA sets a NAAQS at a more stringent level using the authority laid out in Title I, the tightened requirements apply to mobile sources under Title II.

Mobile Source regulation under the Clean Air Act targets engines and the fuel used to power those engines. The Clean Air Act outlines categories of engines: on road, those used in the Nation's light duty and heavy duty vehicle fleet, and off road, those engines used in locomotives, aircraft, recreational vehicles such as boats and jet skis, as well as construction and farm equipment, lawnmowers, and chainsaws. On the fuel side of the equation, the Act provides for the regulation of not only tailpipe emissions but also evaporative emissions from motor fuels.

California Waiver

Unique in Title II of the CAA is what is often referred to as the California waiver, Section 209(b), which provides that the Administrator may waive the prohibition against a State adopting or enforcing any standard relating to the control of emissions from new motor vehicles or new motor vehicle engines as long as the State standards are at least as protective of public health and welfare as the applicable federal standard. In practice, this permitted California to continue to adopt more stringent standards than the rest of the country. Given the State's economic size and market share, California regulations tend to influence national standards. For example, CAFE standards negotiated in 2009 included EPA, the Department of Transportation, California regulators, and the auto industry.

Tailpipe Emissions

The 1990 CAAA expanded EPA's authority so as to require reductions of emissions previously ignored, including evaporative and refueling emissions, cold temperature emissions and air toxics. The amendments outlined new tailpipe emissions standards for light duty cars and trucks (Tier I) and authorized EPA to set more stringent standards down the road (Tier II). Tier II standards phased in beginning with the model year 2004, and attempted to be fuel neutral. Tier II targeted the refining process as well, requiring refiners to reduce the sulfur content in gasoline to 30 parts per million (ppm). This requirement was necessitated by States needing to meet more stringent revised ozone and particulate matter (PM) standards.

Fuel Specifications

Section 211(f) of the CAA prohibits the introduction of a new fuel into commerce unless that fuel is certified to be "substantially similar" to an existing fuel on the market. Under the Act, EPA may waive the prohibition if the manufacturer of the

[1] For the first time, during the 1997 revision of the PM NAAQS, EPA established separate standards for fine particulate matter (smaller than 2.5 micrometers or PM_2) and coarse particulate matter (smaller than 10 micrometers or PM_2).

fuel proves the new fuel or fuel additive (or concentration thereof) will not cause or contribute to a vehicle's failure to meet existing emissions standards.

In the 1990 amendments, Congress sought to address the problem summertime ozone increases, by creating the Reformulated Gasoline (RFG) Program. The RFG Program required that gasoline sold in certain areas (starting with the nine largest metropolitan areas with the most severe summertime ozone levels and other non-attainment areas that opt into the program) be reformulated to reduce emissions of toxics and ozone precursors including volatile organic compounds (VOCs). VOCs are released in part due to the evaporative nature of gasoline. In order to make gasoline cleaner burning, the Act, as part of the RFG program, specified that RFG include two percent by weight oxygen content. The oxygenate requirement was initially met by adding the fuel additive MTBE to gasoline, as ethanol when used as an oxygenate introduced additional volatility, thereby increasing evaporative emissions. The Energy Policy Act of 2005, however, eliminated the oxygenate requirement for the RFG program as the Renewable Fuel Standard (RFS) became the primary driver of gasoline content requirements.

The standard approach used to measure gasoline volatility is in pounds per square inch (psi) of Reid Vapor Pressure (RVP). The higher the RVP, the higher the fuel's volatility or tendency to evaporate. The gasoline standard ranges from 7.0 psi to 9.0 psi for the summer months. Since as mentioned above, ethanol, increases the volatility of gasoline, EPA provided a 1.0 psi (one-pound waiver) for gasoline containing 10 percent ethanol.

Boutique Fuels

Under Section 211(c), the EPA has approved requests for some States to adopt fuel standards that are more stringent than those required under EPA's RFG program. These fuels, often called boutique fuels, are produced for a specific geographic area in order to help States achieve their NAAQS compliance. Boutique fuels produced for one area may not satisfy requirements in another area. The Energy Policy Act of 2005 sought to address the proliferation of boutique fuels by limiting their number.

The Renewable Fuel Standard

The Energy Policy Act of 2005 (EPAct05) established in law a renewable fuel standard (RFS). It required that four billion gallons of renewable fuel be used in the national fuel mix by 2006, rising to 7.5 billion gallons by 2012. The Energy Independence and Security Act of 2007 (EISA) greatly expanded the RFS (RFS2). EISA increased the volume of renewable fuel to be used in the U.S. to 36 billion gallons by 2022. Furthermore, in order to promote the use of advanced biofuels, the amount of corn-based ethanol to be used in meeting the RFS2 was capped at 15 billion gallons. In 2010, the United States consumed approximately 13.2 billion gallons of corn-based ethanol. RFS2 created four categories of biofuels:

- Total *renewable fuels* is the loosest definition, with the only requirement that the biofuel have a lifecycle greenhouse gas (GHG) emission profile that is 20% below the estimated lifecycle GHG emission profile of traditional gasoline. Corn-based ethanol qualifies in this category.
- *Advanced biofuels* must reduce lifecycle GHG emissions by 50% compared with traditional gasoline. Corn-based ethanol does not qualify for this category, but ethanol derived from sugarcane (Brazilian ethanol) does.
- *Cellulosic and agricultural waste-based biofuels* must reduced lifecycle GHG emissions by 60% compared with traditional gasoline. These renewable fuels must be derived from cellulose.
- *Biomass-based biodiesel* must reduce lifecycle GHG emissions by 50% compared with traditional diesel fuel. Qualifying fuels are any diesel made from biomass feedstocks.

RFS2 nests the requirements for the advanced biofuels. For example, in 2022, the RFS mandates the use of 36 billion gallons of biofuel (Table 1). However, only 15 billion can be from corn-based ethanol. The remaining 21 billion must come from advanced biofuels. Of the 21 billion, 16 billion must come from cellulosic, at least one billion from biodiesel, and four billion of unspecified other advanced biofuels.

EPA has the authority to reduce or waive the RFS requirements, in whole or in part, based on the availability of domestic supply. For example, in February 2010, EPA waived the 2010 cellulosic requirement of 100 million gallons to 6.5 million gallons, and in November 2010, EPA waived the 250 million gallon cellulosic requirement for 2011 to 6.6 million gallons. Even if the adjusted volume of cellulosic biofuel

is not actually produced, the obligated parties (including refiners) are still required to buy credits to satisfy the adjusted amount.

Table 1. RFS 1 and 2 Requirements – billions of gallons[2]

Year	RFS1 (EPAct05)[3]	RFS2 Biofuel mandate				
		Total Renewable Fuel	Cap on corn-based ethanol	Advanced Biofuels		
				Cellulosic	Biodiesel	Other
2006	4.00	——	——	——	——	——
2007	4.70	——	——	——	——	——
2008	5.40	9.00	9.00	0.00	0.00	0.00
2009	6.10	11.10	10.50	0.00	0.00	0.10
2010	6.80	12.95	12.00	0.0065	1.15	0.20
2011	7.40	13.95	12.60	0.0066	0.80	0.30
2012	7.50	15.20	12.20	0.50	1.00	0.50
2013	7.60[4]	16.55	13.80	1.00		0.75
2014	7.70	18.15	14.40	1.75		1.00
2015	7.80	20.50	15.00	3.00		1.50
2016	7.90	22.25	15.00	4.25		2.00
2017	8.10	24.00	15.00	5.50		2.50
2018	8.20	26.00	15.00	7.00		3.00
2019	8.30	28.00	15.00	8.50		3.50
2020	8.40	30.00	15.00	10.50		3.50
2021	8.50	33.00	15.00	13.50		3.50
2022	8.60	36.00	15.00	16.00		4.00
2023	--					

[2] Congressional Research Service. "Renewable Fuel Standard (RFS): Overview and Issues". February 1, 2011.
[3] EPAct05 required that for 2013 and thereafter required that a minimum of 250 million gallons of renewable fuel be generated from cellulosic feedstocks.
[4] Calendar years 2013 and beyond are estimated as what would have been required beyond the original mandate.

Unintended Consequences and Potential Conflicts

E15

As a result of approaching the ethanol "blend wall" of 10 percent (E10) and the increasing volumes required by the RFS, EPA, prompted by an application by Growth Energy in March of 2009, has recently permitted the use of intermediate ethanol blends (up to E15) in some vehicles. [5] Despite technical concerns involving emissions, reliability, infrastructure, and liability being raised by a diverse coalition of stakeholders, in October 2010 and January 2011, EPA partially approved waivers for the use of E15 in model year 2001 and newer light-duty motor vehicles. In approving the waiver, EPA was required by Section 211(f) of the CAAA to determine first that E15 would "not cause or contribute to a failure of any emission control device or system." In making the determination, the Administrator relied almost exclusively on a set of tests conducted by the Department of Energy in 2009 and 2010.

In June, EPA mandated a new label to be placed on service station fuel pumps when stations choose to sell E15 to "help reduce the potential for vehicles, engines, and equipment not covered by the partial waiver decisions to be misfueled with E15."

Tier 3

EPA has signaled its intentions to move forward later this year with so-called "Tier 3" standards for light-vehicle emissions and fuels. This forthcoming action, which would strengthen limits on gasoline vapor pressure and sulfur content even further than the current Tier 2 standard, is prompted by the expanded use of renewable fuels under the RFS and the likely expansion of ethanol consumption resulting from the approval of E15. There are several elements of note to this Tier 3 rulemaking:

- Section 211(v) of the CAA requires EPA to first conduct and complete an "anti-backsliding" study to determine if the RFS will "adversely impact air quality." The study was required to be completed 18 months after enactment of the 2007 EISA legislation, but it remains unfinished.
- An analysis conducted earlier this year suggests that Tier 3 standards would result in negative economic outcomes, including the closure of up to seven refineries and gasoline price increases of up to 25 cents per gallon, as well as increased energy use and greenhouse gas emissions in order to comply. [6]
- As a result of the predicted shift by automakers toward direct fuel-injection systems in order to comply with EPA greenhouse gas emissions standards, EPA's Tier 3 rulemaking appears poised to tighten vehicle emissions standards as well, including a first-ever particulate matter emission standard for all light-duty vehicles. [7]
- EPA is considering, as part of the Tier 3 proposal, changing the Agency's certification fuel from E0 (pure gasoline without biofuel additives) to E15 (15 percent ethanol blend). A change in this certification fuel, which is the test gasoline that EPA and automakers use to certify that engines meet emissions standards, could generate significant problems for automobile and engine manufacturers, refiners, and advanced biofuels.

Low-Carbon Fuel Standard

Furthermore, proposed and enacted low-carbon fuel standards at the federal, State, and regional levels create additional regulatory tension and uncertainty in the marketplace. [8] As the Congressional Research Service suggested in a 2008 re-

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[5] For more background information on E15, see the Subcommittee's July 7 hearing, "Hitting the Ethanol Blend Wall: Examining the Science on E15," *http://science.house.gov/hearing/energy-and-environment-hearing-science-e15*.

[6] Baker & O'Brien, Inc., "Potential Supply and Cost Impacts of Lower Sulfur, Lower RVP Gasoline," July 2011, *http://www.api.org/Newsroom/upload/110715_LowerSulfer_LowerRVP_Final.pdf*.

[7] Curt Barry, "Vehicle GHG Controls Drive EPA Plan for Strict PM Limit, Worrying Industry," *Inside EPA*, July 22, 2011.

[8] These efforts include California's Low Carbon Fuel Standard Program (*http://www.arb.ca.gov/fuels/lcfs/lcfs.htm*), the Northeast States for Coordinated Air Use Management's (NESCAUM) proposed Clean Fuel Standard (*http://www.nescaum.org/topics/clean-fuels-standard*), and President Obama's proposed National Low Carbon Fuel Standard (*http://my.barackobama.com/page/content/newenergy_more*).

port on the subject, "The establishment of a Low Carbon Fuel Standard—at either the State or federal level—would add another major regulatory requirement."[9] Studies have indicated that these new standards could significantly raise prices, reduce energy security, and, in some cases, increase greenhouse gas emissions.[10]

[9] Brent Yacobucci, "A Low Carbon Fuel Standard: State and Federal Legislation and Regulations," CRS Report 7-9662, December 23, 2008.

[10] See: IHS, "Assessment of the NESCAUM Economic Analysis of a Clean Transportation Fuels Program for the Northeast/Mid-Atlantic Region," October 22, 2011; Barr Engineering Company, "Low Carbon Fuel Standard 'Crude Shuffle' Greenhouse Gas Impacts Analysis," June 2010, *http://www.npra.org/files/Crude_Shuffle_Report_0616101.pdf*; Michael Canes and edward Murphy, "Economics of a Low Carbon Fuel Standard," 2009, *http://www.marshall.org/pdf/materials/643.pdf*; Charles River Associates, "Economic and Energy Impacts Resulting from a National Low Carbon Fuel Standard," June 2010, *http://consumerenergyalliance.org/wp/wp-content/uploads/2010/06/CRA-LCFS-Final-Report-June-14-2010.pdf*.

Chairman HARRIS. The Subcommittee on Energy and Environment will come to order. Good afternoon. Again, my apologies for the panel for the delay. We just got back from a series of votes, but the good news is we shouldn't have any more during the hearing.

Welcome to today's hearing entitled, "Conflicts and Unintended Consequences of Motor Fuel Standards." In front of you are packets containing the written testimony, biography, and truth in testimony disclosure of today's witness panel.

I now recognize myself for five minutes for an opening statement.

Again, I want to welcome everyone to this afternoon's hearing on, "Conflicts and Unintended Consequences of Motor Fuel Standards."

I would like to note a couple of things at the outset. First, this hearing is not an attack on biofuels. It is about understanding the interrelation of the complex web of government fuel mandates and the economic and environmental consequences that result from those mandates. Second, many of the conflicts highlighted today emanate from a single policy passed by Congress back in 2007, a law expanding the Renewable Fuel Standard to mandate consumption of 36 billion gallons of biofuels by the year 2022. Collectively, these issues make one essential principle abundantly clear: whether through government handouts, as in the case of Solyndra, or through heavy-handed fuel mandates, as in the case of the RFS, the picking of energy winners and losers by government fiat is an exercise in futility destined to fail miserably.

In the last eight months, this Committee has held numerous hearings illustrating EPA's penchant for pursuing outcome-based science. In all the program areas we have examined, the Agency continuously fails to do its homework before rushing into a regulatory judgment. Furthermore, much of the science supported and used as the basis for new regulations is done behind a veil of secrecy, contravening this Administration's promise of transparency.

Consider just a few examples. EPA is undertaking a Tier 3 rulemaking later this year despite not having completed the statutorily required, anti-backsliding analysis due in mid-2009. EPA granted a waiver to allow 15 percent ethanol in our fuel based on a single set of test results that are still not complete and only made public the night before the waiver was granted, ignoring several other relevant test programs. And the Inspector General of EPA recently found that the Administrator's endangerment finding on greenhouse gas emissions failed basic peer review requirements.

EPA's upcoming Tier 3 rulemaking is a perfect case study in regulatory folly. The three major elements of EPA's approach are all being driven by the excesses of past regulatory decisions including the RFS, not by any organic standard emanating from the Clean Air Act.

First, there have been reports that the rule will include the first-ever particulate matter standards for vehicle tailpipes as the result of automakers increasingly shifting to direct fuel-injection systems, itself a trend that is growing in order to comply with EPA's greenhouse gas emission standards. Second, EPA will also seek to tighten sulfur and volatility limits for fuels to offset increases in air pollutants resulting from EPA's Renewable Fuels Standard. Finally, EPA is also proposing to change its gasoline test fuel from E0 to

E15 in order to accommodate increasing amounts of ethanol in our fuel system.

The volumes of biofuels mandated by the RFS were the driving force behind EPA's decision to permit mid-level ethanol blends, and we are seeing similar engine compatibility, liability, and infrastructure issues with higher blends of biodiesel. A study sponsored by the National Renewable Energy Laboratory and released two weeks ago raises even more red flags about the deployment of E15. It showed significant damage to marine engines, a problem unlikely to be mitigated by EPA's watered-down misfueling label.

Similarly, we will also be discussing a recently-released report from the National Research Council on the economic and environmental impacts from U.S. biofuel policy. In addition to finding that RFS-mandated levels of cellulosic ethanol are unlikely to be met, the report also predicted a variety of air, water, and soil quality impacts from increased biofuel production. The study also concluded that the RFS is an ineffective policy for greenhouse gas emission reductions, one of the key motives behind the expanded mandate.

Regulations and standards that create environmental problems that engender these secondary do-over regulations need to be rethought. We need to start thinking about the real objectives these standards are attempting to achieve. Is the goal reduced fossil fuels, low carbon fuels, low sulfur fuels, or reduced imported fuels? What are the real benefits realized with these standards and at what cost? Are we creating an environment that encourages job growth, or are we adding regulatory burdens that will continue to cost more jobs?

As we have seen with regulatory approaches in the past, government intervention more often than not results in significant unintended consequences for the economy and the environment. Some, not all, of those consequences can be avoided with a little forethought and good scientific investigation. I hope the discussion today will help illuminate those areas where additional consideration or scientific investigation is warranted and what objectives we are truly trying to accomplish with current U.S. fuels policy.

[The prepared statement of Mr. Harris follows:]

PREPARED STATEMENT OF REPRESENTATIVE ANDY HARRIS, CHAIRMAN, SUBCOMMITTEE ON ENERGY AND ENVIRONMENT

I want to welcome everyone to this afternoon's hearing on Conflicts and Unintended Consequences of Motor Fuel Standards.

I'd like to note a couple of things at the outset. First, this hearing is not an attack on biofuels. It is about understanding the interrelation of the complex web of government fuel mandates and the economic and environmental consequences that result from them. Second, many of the conflicts highlighted today emanate from a single policy passed by Congress in 2007—a law expanding the Renewable Fuel Standard to mandate consumption of 36 billion gallons of biofuels by 2022. Collectively, these issues make one essential principle abundantly clear: whether through government handouts, as in the case of Solyndra, or through heavy-handed fuel mandates, as in the case of the RFS, the picking of energy winners and losers by government fiat is an exercise in futility destined to fail miserably.

In the last eight months, this Committee has held numerous hearings illustrating EPA's penchant for pursuing outcome-based science. In all the program areas we have examined, the Agency continuously fails to do its homework before rushing into a regulatory judgment. Furthermore, much of the science supported and used

as the basis for new regulations is done behind a veil of secrecy, contravening this Administration's promises of transparency.

Consider just a few examples. EPA is undertaking a Tier 3 rulemaking later this year despite not having completed the statutorily required anti-backsliding analysis due in mid-2009. EPA granted a waiver to allow 15 percent ethanol in our fuel based on a single set of test results that are still not complete—and only made public the night before the waiver was granted—ignoring several other relevant test programs. And the Inspector General of EPA recently found that the Administrator's endangerment finding on greenhouse gas emissions failed basic peer review requirements.

EPA's upcoming "Tier 3" rulemaking is a perfect case study in regulatory folly. The three major elements of EPA's approach are all being driven by the excesses of past regulatory decisions including the RFS, not by any organic standard emanating from the Clean Air Act.

First, there have been reports that the rule will include the first-ever particulate matter standards for vehicle tailpipes as the result of automakers increasingly shifting to direct fuel-injection systems—itself a trend that is growing in order to comply with EPA's greenhouse gas emission standards. Second, EPA will also seek to tighten sulfur and volatility limits for fuels to offset increases in air pollutants resulting from EPA's Renewable Fuels Standard. Finally, EPA is also proposing to change its gasoline test fuel from E0 to E15 in order to accommodate increasing amounts of ethanol in our fuel system.

The volumes of biofuels mandated by the RFS were the driving force behind EPA's decision to permit mid-level ethanol blends, and we are seeing similar engine compatibility, liability, and infrastructure issues with higher blends of biodiesel. A study sponsored by the National Renewable Energy Laboratory and released two weeks ago raises even more red flags about the deployment of E15. It showed significant damage to marine engines, a problem unlikely to be mitigated by EPA's watered-down misfueling label.

Similarly, we will also be discussing a recently released report from the National Research Council on the economic and environmental impacts from U.S. biofuel policy. In addition to finding that RFS-mandated levels of cellulosic ethanol are unlikely to be met, the report also predicted a variety of air, water, and soil quality impacts from increased biofuel production. The study also concluded that the RFS is an ineffective policy for greenhouse gas emission reductions, one of the key motives behind the expanded mandate.

Regulations and standards that create environmental problems that engender these secondary, "do-over" regulations need to be rethought. We need to start thinking about the real objectives these standards are attempting to achieve. Is the goal reduced fossil fuels, low carbon fuels, low sulfur fuels, or reduced imported fuels? What are the real benefits realized with these standards, and at what cost? Are we creating an environment that encourages job growth or are we adding regulatory burdens that will cost more jobs?

As we have seen with regulatory approaches in the past, government intervention more often than not results in significant unintended consequences for the economy and the environment. Some, not all, of these consequences can be avoided with a little forethought and good scientific investigation. I hope the discussion today will help illuminate those areas where additional consideration is warranted and what objectives we are truly trying to accomplish with current U.S. fuels policy.

Chairman HARRIS. The Chair now recognizes Mr. Miller for five minutes for an opening statement.

Mr. MILLER. Thank you, Mr. Chairman. One of the origins of this hearing, it appears, is that the majority needed to cover a variety of topics to placate various industries critical of EPA and State environmental measures, including the Federal Renewable Fuel Standard (RFS2) the California Low-Carbon Fuel Standard, Tailpipe Emission Standards, Tier 3 Motor and Fuel Standards, Greenhouse Gas Emissions Standards for Oil Refineries,and also the EPA's decision to allow the voluntary sale of E15. What am I leaving out? There is a little bit of this, there is a little bit of that.

So we have a seven-witness hearing on motor fuel standards. I am pleased that the EPA is here at this time to testify, and Ms. Oge, at least we will not be talking about you behind your back at this hearing. Most of the issues raised today are actually outside

of our Committee's jurisdiction, so the hearing is on the science behind the standards. Many of the standards are the result of complicated statutory procedures imposed by Congress, but procedures designed to ensure that everyone affected by a regulation will have a chance to be heard, and actually industry has insisted on those standards so they would have an opportunity to be heard in all of those procedures.

And all the standards we discuss today are intended to protect the air we breathe, the water we drink, and to curb our dependence on foreign oil. Our economy is largely built on access to cheap motor fuels, but there are obvious consequences to our dependence on those fuels. Our transportation sector consumes 27 percent of the energy used in our country and makes us very vulnerable to economic disruption from the interruption of our oil supply from some of the most unstable nations in the world.

And the use of motor fuel produces 1.8 million metric tons of greenhouse gases annually, polluting the environment with hazardous contaminants that can cause severe and chronic respiratory illnesses.

The minority's one witness today, not counting Ms. Oge, will point out that regulations spur innovation. For example, the U.S. economy has grown by 64 percent since the enactment of the Clean Air Act, and the benefits of the Act are 40 times the cost of the regulation. Now, the innovation that has resulted from the Act's requirements has generated 65,000 American jobs. And other industries not invited to testify today support various regulations and have already invested greatly in the research and development to meet the standards of regulations.

We will submit written statements for the record from some of those uninvited industries. Unfortunately, we will not hear today from a parent who has made a panic trip to an emergency room with a child suffering from an asthma attack. That should also be part of this hearing.

I yield back the balance of my time.

[The prepared statement of Mr. Miller follows:]

PREPARED STATEMENT OF REPRESENTATIVE BRAD MILLER,
RANKING MEMBER, SUBCOMMITTEE ON ENERGY AND ENVIRONMENT

Thank you, Chairman Harris.

What are the origins of this hearing? It appears that the majority needed to cover a variety of topics to placate various industries critical of EPA and State environmental measures, including the Federal Renewable Fuel Standard (RFS2), the California Low Carbon Fuel Standard, tail pipe emission standards, the Tier 3 Motor and Fuel Standards, and greenhouse gas emission standards for oil refiners. Oh, also the EPS's decision to allow the vountary sale of E15.

What am I leaving out?

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And other industries not invited to testify today support various regulations and have already invested greatly in the research and development to meet the standards. We will submit written statements for the record from those uninvited industries.

Unfortunately, we won't hear today from a parent who has made a panicked trip to the emergency room with a child suffering from an asthma attack. That should be part of this hearing, too.

Chairman HARRIS. Thank you very much, Mr. Miller. If there are Members who wish to submit additional opening statements, your statements will be added to the record at this point.

At this time, I would like to introduce our witness panel. Our first witness is Mr. Brendan Williams, Senior Director of Advocacy for the National Petrochemical and Refiners' Association. Before joining NPRA, Mr. Williams spent over seven and one-half years on Capitol Hill specializing in energy and environment policy.

The next witness is Dr. Ingrid Burke, Director of the Haub School and Ruckelshaus Institute of Environment and Natural Resources at the University of Wyoming and Co-Chair of the National Research Council Committee on Economic and Environmental Impacts of Increasing Biofuels Production. Dr. Burke has served as a member of several national research council committees to review national environmental research programs and policies.

Next we have Ms. Margo Oge, the Director of the Office of Transportation and Air Quality at the EPA, where she has worked since 1980.

Our fourth witness is Dr. Jay Kesan, Professor and H. Ross and Helen Workman Research Scholar and Program Leader of the Biofuel Law and Regulation Program at the Energy Biosciences Institute at the University of Illinois College of Law. His work focuses on patent law, intellectual property, entrepreneurship, Internet law and regulation, digital government, agricultural biotechnology law, and biofuels regulation.

Next witness is Mr. Bob Greco, the Group Director for Downstream and Industry Operations at the American Petroleum Institute. Prior to his 21-year career at API, Mr. Greco was an Environmental Engineer with EPA with expertise in automotive emission control technologies.

Next we have Mr. David Hilbert, a Thermodynamic Development Engineer for Mercury Marine. His main responsibilities include engine performance and emissions hardware development and base engine calibration mapping. He conducted the recently-released National Renewable Energy Lab report on high ethanol fuel endurance.

Our final witness is Mr. Jack Huttner, the Executive Vice President for Commercial and Public Affairs at Gevo, Incorporated. Is that the way it is pronounced?

Mr. HUTTNER. Gevo.

Chairman HARRIS. Gevo. Gevo, Incorporated. Prior to joining Gevo, he was Vice President of Commercial and Public Affairs at Dupont Dansico Cellulosic Ethanol, and he was Vice President of Business Development at Genencor, the industrial biotechnology division of Dansico A/S.

Thank you all for appearing before the Subcommittee today, and, again, thank you for your patience while we were voting. As our witnesses should know, spoken testimony is limited to five minutes each, after which the Members of the Committee will have five minutes each to ask questions.

I now recognize our first witness, Mr. Brendan Williams of the National Petrochemical and Refiners' Association. Mr. Williams.

STATEMENT OF MR. BRENDAN WILLIAMS,
SENIOR DIRECTOR OF ADVOCACY,
NATIONAL PETROCHEMICAL AND REFINERS' ASSOCIATION

Mr. WILLIAMS. Thank you, Mr. Chairman. Good afternoon, Chairman Harris, Ranking Member Miller, and Members of the Subcommittee. I am Brendan Williams, Senior Director of Advocacy for NPRA, the National Petrochemical and Refiners' Association. I thank you for giving me the opportunity to testify today.

NPRA is a trade association representing high-tech American manufacturers of virtually the entire supply of gasoline, diesel fuel, jet fuel, other fuels, and home heating oil, along with petrochemicals used as building blocks for thousands of products. We favor sound and sensible environmental regulations. We are strongly committed to clean air and water. We have an outstanding record of compliance with regulations issued by the Environmental Protection Agency and other agencies, and we have invested hundreds of billions of dollars to dramatically reduce emissions.

We have helped make America's air cleaner today than it has been in generations. Refiners have cut sulfur levels in gasoline and diesel fuel by about 90 percent, and we have reduced benzene in conventional gasoline by 45 percent in recent years.

EPA data shows that total emissions of the six principle pollutants in the United States have dropped by 57 percent since 1980. Ozone levels have decreased by 30 percent. EPA data indicates there will be continued reductions in the years ahead under existing regulations.

Despite this great progress, we are concerned that EPA and other agencies have moved away from sensible regulation towards an environment characterized by overregulation. This makes unreasonable and often conflicting demands on our members to make changes in manufacturing processes that carry an extremely high cost and bring little or no environmental benefit.

Overregulation raises energy costs for every consumer. It strengthens foreign competitors eager to replace American manufacturers and American workers. It weakens U.S. economy, and it makes America more reliant on unstable parts of the world for vital fuels and petrochemicals.

A Department of Energy report concluded that the burden of federal regulations was a significant factor in the closure of 66 refineries in the past 20 years. Just since 2008, the recession, our refin-

ery closures have led to 3,000 lost jobs in American refineries, a handful of refineries are also threatened with closure over the next year if they can't be sold.

We have seen too many American manufacturing industries go overseas in recent decades, which led to millions of lost jobs, and we don't want the same thing to happen if overregulation forces the U.S. refining industry to move overseas.

American manufacturers of transportation fuel are being hit with a blizzard of regulations. Some of these involve what are called Tier 3 regulations to reduce sulfur in gasoline. Others deal with mandate under the Renewable Fuel Standard involving ethanol and other biofuels, and others involve greenhouse gas regulations. These measures pose challenges individually; however, their impact is exacerbated because many individual regulatory demands are simply impossible to meet without coming into conflict with other regulations.

One example deals with potential Tier 3 requirements and EPA's greenhouse gas standards. Additional sulfur controls for the fuel supply called for in Tier 3 will require more energy-intensive processes which will actually increase greenhouse gas emissions at refineries.

A similar example of conflicting regulations can be found in relation to the Renewable Fuel Standard. The National Research Council said increased ethanol required under the standard could increase ozone and particulate matter and other emissions, but the Renewable Fuel Standard also requires an amount of ethanol that cannot be realistically introduced into the fuel supply given current infrastructure and consumer demand. Such conflicts are costly and difficult to address.

Unfortunately, the size, scope, and cumulative burden of current and impending regulatory activity is hurting the ability of refiners to preserve existing jobs and create new ones. Overregulation is also adversely impacting our ability to serve the American people with domestically produced, reliable transportation fuels.

We believe America's national interest would best be served by a comprehensive and objective cost-benefit analysis of new and existing federal regulations. It is time for higher consumer costs, lost jobs, and damage to America's economic and national security to be considered as relevant factors in determining whether even more stringent regulations will do more harm than good.

Thank you again for the opportunity to be here, and I will be happy to take any questions at the appropriate time.

[The prepared statement of Mr. Williams follows:]

PREPARED STATEMENT OF MR. BRENDAN WILLIAMS,
SENIOR DIRECTOR OF ADVOCACY,
NATIONAL PETROCHEMICAL AND REFINERS' ASSOCIATION

Introduction

Chairman Harris, Ranking Member Miller and Members of the Subcommittee, thank you for giving me the opportunity to testify at today's hearing dealing with conflicts and unintended consequences of motor fuel standards. I'm Brendan Williams, and I serve as the Senior Director of Advocacy of NPRA, the National Petrochemical & Refiners Association. Since virtually every American drives or travels

in vehicles powered by motor fuels manufactured by NPRA members, the topic of this hearing directly affects just about everyone in our Nation.

NPRA is a trade association representing high-tech American manufacturers of virtually the entire U.S. supply of gasoline, diesel, jet fuel, other fuels and home heating oil, as well as the petrochemicals used as building blocks for thousands of vital products in daily life. NPRA members make modern life possible and keep America moving and growing as they meet the needs of our Nation and local communities, strengthen economic and national security, and provide jobs directly and indirectly for more than two million Americans.

For well over 100 years, our refining members have been serving the American people by manufacturing the most efficient form of safe, proven, and reliable motor fuels. NPRA members have done this while making tremendous strides to improve the environment, strengthen America's economy, and provide good-paying jobs for American workers—many of them union members.

There is a very close connection between federal energy and environmental policies. Unfortunately, these policies are often debated and decided separately and without coordination. As a result, positive impacts for one policy area sometimes conflict with or even undermine goals and objectives in the other. Congress and the Administration can advance both the cause of cleaner fuels and preserve the domestic refining industry and the jobs it supports by adopting this principle of balance as part of our Nation's energy and environmental policies.

A healthy and diverse U.S. refining industry serves the Nation's interest by maintaining a secure supply of energy products. Rationalizing and balancing our Nation's energy and environmental policies will protect this key American resource. Given the challenges of the current and future refining environment, America is fortunate to retain a refining industry with many diverse and specialized participants. Refining is a tough business, but the continuing diversity and commitment to performance within the industry demonstrate that it has the vitality needed to continue its important work, especially with the help of a supply-oriented national energy policy.

We support sound and sensible environmental and other regulations. Our members are strongly committed to clean air and water, have an outstanding record of compliance with Environmental Protection Agency and other regulations, and have invested hundreds of billions of dollars to dramatically reduce emissions as measured by EPA.

As a result of these emissions reductions by our members and by other industries, America's air today is cleaner than it has been in generations. Refiners have cut sulfur levels in gasoline by 90 percent just since 2004. We have also reduced sulfur in diesel fuel by more than 90 percent since 2005 and reduced benzene in conventional gasoline by 45 percent since 2010. EPA data shows that total emissions of the six principal air pollutants in the United States have dropped by 57 percent since 1980, and ozone levels have decreased by 30 percent. These reductions occurred even as industrial output and the number of vehicles on the road have increased. EPA data indicates there will be continued reductions in the years ahead under regulations already in place.

Refiners have spent nearly $50 billion just to remove sulfur from gasoline and diesel fuel and to manufacture reformulated gasoline. NPRA members have additionally addressed requirements for low Reid Vapor Pressure gasoline, including specially blended fuels required by State Implementation Plans under the Clean Air Act (CAA), which have reduced hydrocarbon emissions, an ozone precursor.

Despite the great progress we have made in environmental stewardship under the CAA and other laws, we are concerned that EPA and other agencies have at times moved from regulation to overregulation, making unreasonable and often conflicting demands on our members to spend enormous sums to make changes in their manufacturing processes that bring little or no significant environmental benefit.

Unintended Consequences

The demands of environmental overregulation—some of which are impossible to achieve without coming in conflict with other regulations—would raise energy costs for every American consumer. They would also strengthen foreign competitors eager to replace American manufacturers and American workers, weaken the U.S. economy, make America more reliant on nations in unstable parts of the world for vital fuels and petrochemicals, and endanger our national security.

These are not alarmist statements—they are simple facts about the consequences of overregulation. The refining industry has historically been very cyclical and volatile financially. A Department of Energy report issued in March found that refining margins have been continuously decreasing over the past four years (Exhibit A). The report also concluded that the compounded burden of federal regulations was a sig-

nificant factor in the closure of 66 petroleum refineries in the United States in the past 20 years (Exhibit B). Just since 2008, the recession and refinery closures have led to 3,000 lost jobs at American refineries. A handful of refineries are threatened with closure in the next few months if they cannot be sold. Some of the lost supply from shuttered refineries has been made up through capacity expansions at other facilities, and overall capacity has still been increasing. However, the rate of new capacity coming online is decreasing due to financial pressures and the threat of overseas competition—factors that are exacerbated by a domestic environment of overregulation.

Exhibit A

Figure 8. Sample Refining Margins for Large and Small Refiners 2004 – 2009

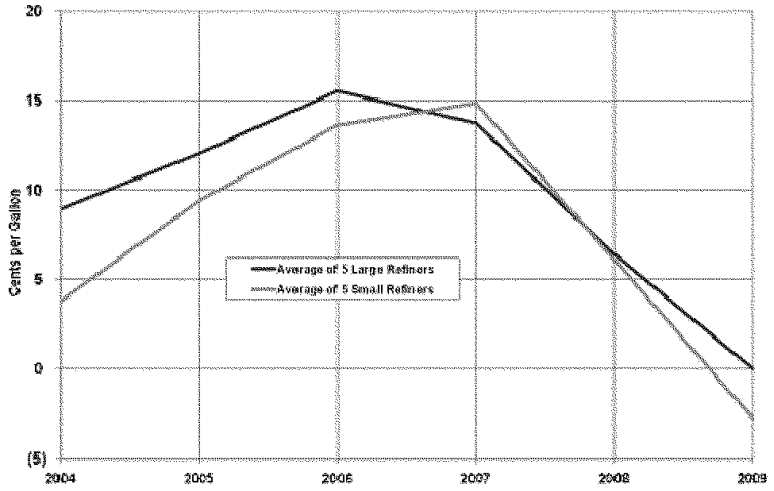
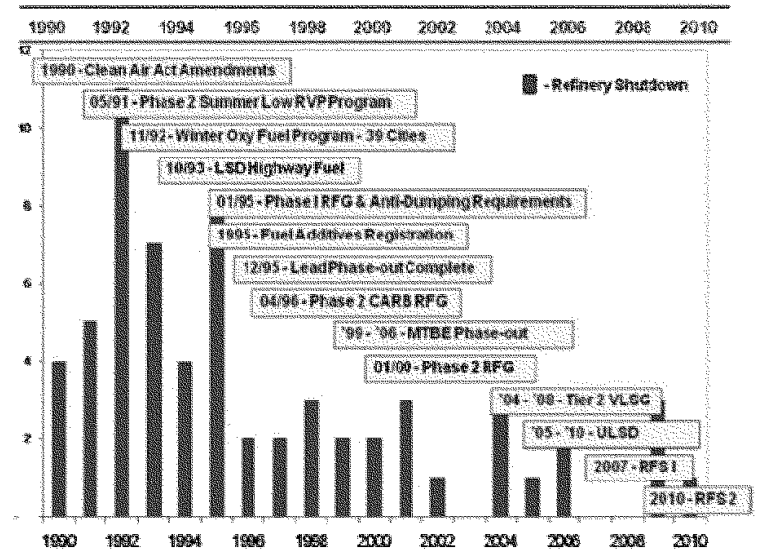


Exhibit B

Figure 9. U.S. Refined Product Environmental Regulations 1990-2010



Source: SAIC, 2010, EIA Table 15 - Refineries Permanently Shut Down, 2010.

(Source: U.S. Department of Energy, Office of Policy and International Affairs, *Small Refinery Exemption Study—An Investigation Into Disproportionate Economic Hardship*, P. 28–30, found at: *http://www.epa.gov/otaq/fuels/renewablefuels/compliancehelp/small-refinery-exempt-study.pdf*.)

We've seen how much of the American textile, steel, auto, appliance, and other manufacturing industries have moved to foreign nations in recent decades, with the tragic loss of millions of American jobs. We don't want the same thing to happen to our members and their workers if overregulation forces much of the refining industry to move from the United States to other nations as well. At a time of high unemployment and a poorly performing national economy, the last thing America needs to do is worsen conditions for another important U.S. manufacturing sector.

The manufacturers of motor fuels are being hit with a regulatory blizzard that poses a significant threat to both refinery operations and our Nation. Some of these regulations involve what are called Tier 3 regulations to reduce sulfur in gasoline, requirements under the Renewable Fuel Standard (RFS) involving ethanol and other biofuels, and greenhouse gas (GHG) regulations, to name a few.

We believe America's national interest would best be served by comprehensive and objective cost-benefit analyses of these and other federal regulations. Existing regulations also need to be examined so those that do more harm than good can be eliminated. It is not realistic to demand that every last molecule of emissions be eliminated—no matter how insignificant, and regardless of the cost in lost jobs, harm to consumers, and harm to our Nation. Yet all too often, overregulation of motor fuels and environmental overregulation takes this approach.

Conflicting Regulations

We understand that different federal and state regulatory agencies have a hard time balancing the need for effective regulation with the demands of meeting sometimes conflicting decisions from the courts, positions of public interest groups, and even newly enacted laws. However, the size, scope, and cumulative burden of current and impending regulatory activity is creating both significant regulatory uncertainty and a slew of conflicting regulations that will impose significant burdens on domestic fuel manufacturers.

Looking in more detail at the various regulations facing our industry helps illustrate the problem of conflicting regulations.

A. Tier 3 Gasoline Sulfur Regulations Conflict with GHG Requirements

Under the CAA, EPA has adopted a series of increasingly stringent rules to reduce the amount of sulfur allowed in gasoline. Since 2004, EPA's Tier 2 rules have reduced sulfur levels in gasoline by 90 percent, from an average of 300 parts per million in 2004 to an average of 30 parts per million today. We have seen no evidence that further sulfur reductions to enable future vehicle technologies are needed.

Nevertheless, EPA is proceeding with what is known as a Tier 3 rulemaking as part of its general authority to regulate fuels under the CAA. The rule would impose a high-cost, minimal-benefit regulatory requirement on America's already heavily regulated fuel supply. The rule could lead to significant domestic fuel supply reductions, higher petroleum product imports, potentially increased consumer costs, increased refinery emissions, closed U.S. refineries, and reduced energy security.

A process called hydrotreating is the principal technology used to reduce sulfur in petroleum products, including motor fuels such as gasoline and diesel. This and other such technologies require energy consumption that results in increased GHG emissions and will also increase emission of other criteria pollutants. As a result, a regulation requiring a reduction of sulfur in petroleum fuel increases emissions that refiners are being told they must reduce under other CAA regulations.

Although refiners have already slashed sulfur levels in gasoline by 90 percent in the past seven years, EPA's Tier 3 rulemaking could require further reductions in sulfur levels in gasoline to an average of 10 parts per million—a 70 percent change from today's already low levels, while also reducing the gasoline volatility. EPA expects to issue a proposed rule by the end of 2011 and a final rule in 2012. There is no reason to regulate sulfur levels further. Sulfur emissions from cars are minimal.

In addition, the Energy Independence and Security Act of 2007 (Section 209) requires EPA to conduct an anti-backsliding study to determine whether mandated renewable fuel volumes will adversely impact air quality. The results of this study are critical to assessing whether or not the current RFS will hamper air quality, as well as how to mitigate such impacts and whether changes to the petroleum portion of the fuel supply are the most cost-effective way to address the issue.

The anti-backsliding study was due in the summer of 2009. It was to be followed up with promulgated regulations to mitigate any potential impacts identified in the study by December 2010. Congress clearly required the study as a precursor to potential regulations, which the statute states should occur 18 months later. However, EPA has not completed this study, but intends to move forward with the Tier 3 proposal anyway. The agency said it will release the study at the same time it releases its proposed Tier 3 regulations. This is contrary to Congressional intent, which clearly indicated the anti-backsliding study was to be completed prior to any new regulations being promulgated. This was to be a sequential schedule, not a concurrent one. EPA should release the study to assess the feasibility of and proper approach to any additional fuels regulations.

E15 and the Renewable Fuel Standard

Another set of EPA regulations of motor fuels that is causing regulatory conflicts and problems for refiners and consumers involves the size and scope of the ethanol mandate created in the 2007 expansion of the RFS.

EPA published a decision last November for approval of a partial waiver with conditions that would allow gasoline containing 15 percent ethanol—known as E15—to be sold into the marketplace for use in cars and light trucks produced in model year 2007 and later. EPA later ruled that E15 could be sold for use in vehicles produced in model year 2001 and later. In addition to being illegal, these decisions hold the potential to create significant problems in the marketplace.

As NPRA and many other groups argue in a lawsuit, EPA does not have the legal authority to grant a partial waiver. Section 211(f)(4) of the CAA is clear on this point, stating that EPA has to determine that any fuel or fuel additive "will not cause or contribute to a failure of any emission control device or system (emphasis added)." The CAA does not give EPA discretion to approve a fuel or fuel additive for sale if it will cause or contribute to the failure of some emission control devices and not others.

Because E15 would theoretically be sold under the same canopy as regular gasoline, there is a high likelihood of consumer misfueling. This is a concern because several studies show that gasoline blends containing more than 10 percent ethanol could lead to engine damage in older vehicles and non-road engines, such as those in chain saws, lawnmowers, boats and snowmobiles. For example, a recent study by the National Renewable Energy Laboratory on testing conducted on the effects of E15 on three outboard boat engines found that E15 caused problems with engine performance, increased fuel consumption, and increased nitrogen oxide emissions.

Ironically, an increased ethanol blend could also damage older cars' catalytic converters, which are installed to reduce emissions. In addition to engine and catalytic converter damage, studies have shown that as ethanol content in fuel increases, it burns hotter and is more corrosive. The combined effect of fuel burning hotter and the corrosive effects of ethanol create the possibility for serious physical injury to people who may misfuel and potential physical damage to vehicle fuel tanks and fuel dispensing equipment. Sufficient testing to assess the impact of these fuel blends on all automobiles—both old and new—and non-road engines has not been completed.

Industries ranging from outdoor power equipment manufacturers to automakers to food producers have all expressed concern over EPA's E15 waiver. However, EPA has ignored ongoing testing related to E15 and made a premature decision to approve the fuel. The same decision to approve E15 also contains a proposal for E15 misfueling mitigation. Therefore, EPA made a decision knowing that it would cause problems and initiated a rulemaking at the same time to mitigate the problems that the EPA itself created.

EPA could have decided to deny the request to approve E15 as gasoline, but chose to approve it partially and conditionally. This decision has put refiners and consumers at significant risk and the E15 misfueling mitigation rule—a cautionary label posted at service stations—is a woefully ineffective warning device.

The American people are the losers in this situation because EPA has violated President Obama's 2009 commitment to them to put science ahead of politics. Consumers rely upon their government to ensure that the products offered are safe for the intended use. EPA's partial waivers for E15 ignore this responsibility. American families, farmers, truckers, and businesses rely on NPRA members millions of times every day to provide affordable, reliable, and safe fuels for use in their gasoline-powered on-road and non-road engines. EPA's partial waiver decisions undermine this reliance.

EPA is rushing to bring E15 to the marketplace and putting consumers at risk. Congress should not allow EPA to continue down this path. Congress should repeal EPA's partial waivers for E15.

This problem with EPA's E15 decisions is just one example of the numerous problems associated with an ill-crafted federal RFS. The existing program contains an extremely aggressive schedule for introducing a large amount of ethanol into the marketplace. Such an implementation schedule raises questions of feasibility, liability, and other economic costs for both refiners and consumers. If the existing RFS program is carried out without changes, it will create great market and economic uncertainty, which will in turn threaten additional refining investment and job growth and harm consumers.

The RFS is challenging and faces several hurdles. Given the aggressive schedule of the mandate and the limits of what fuel and vehicle infrastructure can handle, our Nation will soon face a practical limit into the amount of ethanol that can be pushed into the fuel supply without causing significant consumer disruption. This so-called "blendwall" will be reached when nearly all of the gasoline in the country contains 10 percent ethanol and there is a portion of E85 (fuel containing 85 percent ethanol, 15 percent gasoline) being sold for use in Flex Fuel Vehicles (FFVs).

However, consumers have been slow to accept E85, and it does not shape up to be a viable compliance option for the RFS. For example, E85 has low energy content and could be used in cars not designed for the fuel or in small engines. No small engines are designed for E85, and only a small fraction of the fleet of cars is designed for the fuel. E85 requires an expensive investment at retail stations because of the corrosive nature of ethanol. This issue is yet another in a panoply of problems associated with the current structure of the RFS. Congress should address these issues to protect American drivers and consumers.

Conclusion

NPRA members want a clean environment and have worked hard and invested heavily to achieve that goal. We have made big reductions in emissions, and more reductions will continue under existing regulations. But we want sound science and cost-benefit analyses to be used to examine which environmental regulations are in the best interests of the American people, looking at a broad range of criteria.

Even when excessive regulations are imposed with the best of intentions, they can have harmful unintended consequences. Sometimes these harmful consequences—like a rise in consumer energy costs—are welcomed by opponents of fossil fuels, because these higher costs tilt the playing field to make other energy sources more competitive in the marketplace.

EPA should not have unchecked power to take any action it wants—without specific authorization by Congress—in the single-minded pursuit of unrealistic and harmful overregulation. It's time for higher consumer costs, lost jobs, and damage to America's economic and national security to be considered as relevant factors in weighing whether ever-more-stringent regulations do more harm than good.

NPRA is ready to participate in an intellectually honest dialogue about how to build a stronger economy, a brighter energy future, and a more prosperous America.

Chairman HALL [Presiding]. Thank you, and I now recognize our second witness, Dr. Ingrid Burke, from the University of Wyoming.

STATEMENT OF DR. INGRID BURKE, DIRECTOR, HAUB SCHOOL AND RUCKELSHAUS INSTITUTE OF ENVIRONMENT AND NATURAL RESOURCES, UNIVERSITY OF WYOMING, AND CO–CHAIR, NATIONAL RESEARCH COUNCIL COMMITTEE ON ECONOMIC AND ENVIRONMENTAL IMPACTS OF INCREASING BIOFUELS PRODUCTION

Ms. BURKE. Thank you. Good afternoon, Mr. Chairman and Members of the Committee. I served as the Co-Chair of the National Research Council Committee that authored the report, "Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy." This study was mandated by Congress

in the Energy and Independence and Security Act of 2007 and the 2008 Farm Bill.

The study committee was asked to discuss the current and projected environmental harm and benefits of biofuel production as it increased in the United States to meet the biofuel consumption mandate of the Renewable Fuel Standard or RFS2. Today I will present our key findings in three areas: greenhouse gas emissions, air quality, and water quality.

First, we found that if the consumption mandate of 36 billion gallons of biofuels is to be met in 2022, the effect on greenhouse gas emissions compared to using an energy equivalent of petroleum-based fuels is uncertain. Many factors influence greenhouse gas emissions from biofuel production. They include the type of feedstock, management practices, and the features of the individual site. On the whole, the use of crop and forest residues for biofuels tends to emit lower amounts of greenhouse gases than the use of annual crops such as corn-based ethanol for biofuels.

If dedicated energy crops such as switchgrass are to be grown to meet the consumption mandate for cellulosic biofuels, conversion of both cultivated and uncultivated land will most likely be required, and this could result in market-mediated land-use changes that could result in additional greenhouse gases.

Although RFS2 imposes restrictions to discourage some types of land clearing or land cover change for biofuel production in the United States, it cannot prevent land use or land cover changes overseas.

In summary, because net greenhouse gas emissions depend upon site-specific management decisions made given the market conditions and available technologies at any given time, the extent to which increasing biofuel production in the United States to meet RFS2 consumption mandates will result in greenhouse gas emissions compared to using petroleum-based fuels is uncertain.

Second, I will speak to the report summary of the effects of RFS2 on air quality. In general, gasoline and ethanol emit similar amounts of major pollutants such as particulate matter, nitrogen oxides, volatile organic compounds, and ammonia during vehicle use. That is from vehicle evaporative and tailpipe emissions.

However, the amounts of these air pollutants emitted during the fuel production are typically higher for corn grain or cellulosic ethanol than for petroleum-based fuels. As such, compared to the full life cycle of gasoline, the production and use of biofuels tends to result in higher atmospheric concentrations of volatile organic compounds, nitrous oxides, particulate organic matter, and ammonia on a national average, and the effects of this on human health depend greatly on exposure quantity and duration.

Third and finally, water quality effects of increasing biofuel production also largely depend upon how it is done on feedstock type, site-specific factors, management practices used in feedstock production, and in conversion yield. There is evidence that RFS2 and the push of biofuels has caused more land to come into corn production. Increases in corn production have contributed to increased nutrient loadings to surface waters and to exacerbating eutrophication and hypoxia.

A recent analysis of data from the National Water Quality Assessment showed increasing concentration and flux of nitrate in the Mississippi River. Perennial and short-rotation woody crops for cellulosic feed stocks and use of residues hold promise for improving water quality under RFS2 because these crops require lower agricultural—agrichemical inputs than corn, and perennial root systems can be used to decrease nutrient loadings to streams compared to other crop management regimes. Taking the consumption mandates for different types of biofuels into account, the effect of producing biofuels in the United States adequate to meet RFS2 in 2022 on water quality is uncertain.

In summary, the effects of RFS2 on greenhouse gas emissions, on air quality, and on water quality, as well as other environmental responses, are highly dependent upon what kinds of biomass feed stocks are chosen by our producers, the management choices that they make, and market-mediated responses in other land use for agricultural production in the United States.

Thank you for the opportunity to testify. I am happy to answer any questions the Subcommittee may have.

[The prepared statement of Dr. Burke follows:]

PREPARED STATEMENT OF DR. INGRID BURKE,
DIRECTOR, HAUB SCHOOL AND RUCKELSHAUS INSTITUTE OF ENVIRONMENT AND NATURAL RESOURCES, UNIVERSITY OF WYOMING,
AND CO–CHAIR, NATIONAL RESEARCH COUNCIL COMMITTEE ON ECONOMIC AND ENVIRONMENTAL IMPACTS OF INCREASING BIOFUELS PRODUCTION

Good afternoon, Mr. Chairman and Members of the Committee. My name is Indy Burke. I am the Director of the Haub School and Ruckelshaus Institute of Environment and Natural Resources and Wyoming Excellence Chair and Professor at the University of Wyoming. I served as the Co– Chair of the Committee on Economic and Environmental Effects of Increasing Biofuels Production of the National Research Council (NRC). The Research Council is the operating arm of the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine of the National Academies, chartered by Congress in 1863 to advise the government on matters of science and technology. The report *Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy* is the product of an NRC study mandated by Congress in the Energy and Independence and Security Act of 2007 and the 2008 Farm Bill.

The study committee was asked to discuss the potential environmental harm and benefits of biofuel production if it is to be increased in the United States to meet the biofuel consumption mandate of the Renewable Fuel Standard 2 (RFS2). The study relies on data from literature published up to the time of its preparation, and it found that if the consumption mandate of 36 billion gallons of biofuels is to be met in 2022, the effect on greenhouse gas emissions compared to using the energy-equivalent of petroleum-based fuel is uncertain. Greenhouse gases are emitted into the atmosphere or removed from it during different stages of biofuel production—for example, carbon dioxide is removed from the air by plants during photosynthesis, but it is also emitted from fermentation and the use of fossil fuels when biofuels are produced, as well as from the combustion of biofuels themselves. Many factors, including the type of biofuel feedstock and the management practices used in growing it, influence greenhouse gas emissions of biofuels. For example, biofuel feedstock type and site location affect carbon storage in soil; farmer choices about nutrient management practices, also determined by the biofuel feedstock type and site location, affect fertilizer input and gaseous losses of nitrous oxide, another greenhouse gas, through denitrification.

Increasing biofuel feedstock production also could cause direct and indirect land-use changes that might alter the greenhouse gas balance. If the expanded biofuel feedstock production involves removing perennial vegetation on a piece of land and replacing it with an annual commodity crop, then the land-use change would incur a one-time greenhouse gas emission from biomass and soil that could be large enough to offset greenhouse gas benefits gained by displacing petroleum-based fuels

with biofuels over subsequent years. Furthermore, such land conversion may disrupt any future potential for storing carbon in biomass and soil. In contrast, planting perennial crops in place of annual crops could potentially enhance carbon storage in that site.

In addition to land-use conversion that is directly linked to biofuel feedstock production, indirect land-use change occurs if land used for production of biofuel feedstocks causes new land-use changes elsewhere through market-mediated effects. The production of biofuel feedstocks can constrain the supply of commodity crops and raise prices. If agricultural growers anywhere in the world respond to the market signals (higher commodity prices) by expanding production of the displaced commodity crop, indirect land-use change occurs. This process might lead to conversion of noncropland (such as forests or grassland) to cropland. Because agricultural markets are intertwined globally, production of biofuel feedstock in the United States is likely to result in land-use and land-cover changes somewhere in the world, which could, in turn, result in one-time greenhouse gas emissions from biomass and soil. Because greenhouse gases are well mixed in the atmosphere, their effects are global, irrespective of where they were emitted. The extent of those biofuel-induced, market-mediated, land-use changes and their net effects on greenhouse gas emissions are uncertain.

Among the different types of biofuel feedstocks, crop and forest residues will likely not contribute much greenhouse gas emissions from land-use or land-cover changes because they are products of existing agricultural and forestry activities. However, adequate residue would have to be left in the field to maintain soil carbon. If dedicated energy crops such as switchgrass and Miscanthus are to be grown to meet the consumption mandate for cellulosic biofuels, conversion of uncultivated cropland will likely be required, resulting in the displacement of commodity crops and pastures. Although RFS2 imposes restrictions to discourage biofuel feedstock producers from land-clearing or land-cover change in the United States that would result in net greenhouse gas emissions, the policy cannot prevent market-mediated effects in the United States or abroad, nor can it control land-use or land-cover changes in other countries. In summary, because net greenhouse gas emissions depend on all of these issues described above-site, biofuel feedstock, fertilization, irrigation, direct and indirect land-use change, and residue management, the extent to which increasing biofuel production in the United States to meet the RFS2 consumption mandate will result in savings in greenhouse gas emissions compared to using petroleum-based fuels is uncertain.

As in the case of greenhouse gas emissions, comparison of other air pollutant emissions from biofuels and petroleum-based fuels needs to be considered over the life cycles of the fuels. Production and use of ethanol results in higher concentrations of such pollutants affecting air quality as volatile organic compounds, nitrous oxides, particulate matter, and ammonia than gasoline on a national average. On the whole, estimates of emissions of pollutants affecting air quality from using corn-grain or cellulosic ethanol and gasoline in vehicles (including tailpipe emissions and evaporative emissions from vehicles and filling station) are comparable. However, the pollutant amounts emitted during the fuel-production phase (including feedstock production and transportation) are typically higher for corn-grain or cellulosic ethanol than for petroleum-based fuels. Unlike greenhouse gases, pollutants affecting air quality have local and regional effects on the environment. The potential extent to which these pollutants harm human health and well-being depends on whether the pollutants are emitted close to highly populated areas or to agricultural areas.

Other than greenhouse gas emissions, the water quality effects of increasing biofuel production also largely depend on feedstock type, site-specific factors such as soil and climate, management practices used in feedstock production, land condition prior to feedstock production, and conversion yield. There is evidence that RFS2 and the push of biofuels has caused more land to come into corn production. Increases in corn production have contributed to increasing nutrient loadings to surface water and to exacerbating eutrophication and hypoxia. A recent analysis of data from the National Water Quality Assessment showed increasing concentration and flux of nitrate in the Mississippi River. Increasing corn production to produce corn-grain ethanol for meeting RFS2 likely will have additional negative environmental effects. Perennial and short-rotation woody crops for cellulosic feedstocks hold promise for improving water quality under RFS2 because those crops require lower agrichemical inputs than corn, and their perennial root systems can be used to decrease nutrient loadings to streams compared to other crop management regimes. Harvesting crop residues for biofuel would not require much additional nutrient input, but an adequate amount of residues would have to be left in the field to prevent soil erosion. Certain sites could withstand about 40 to 50 percent crop-residue removal. Taking the consumption mandates for different types of biofuels into account, the effect of

producing biofuels in the United States adequate to meet the RFS2 in 2022 on water quality is uncertain. The effect on water quality will depend on site-specific details of the implementation of RFS2, and particularly the balance of feedstocks and levels of inputs.

Consumptive water use is generally higher for biofuel production than for petroleum-based fuel production on an energy-equivalent basis. (The energy content of ethanol is about two-thirds of that of an equivalent volume of gasoline.) The range of estimates for biofuels (2.9–1,500 gallons per gallon of gasoline equivalent) is much wider than that for petroleum-based fuels (1.9–6.6 gallons per gallon of gasoline equivalent). The large range of estimates for biofuels can be mostly attributed to absence or presence of irrigation during biomass production. Estimates for consumptive water use in biorefineries that convert biomass to fuels are between 2.9 and 20 gallons of water per gallon of gasoline equivalent (four gallons of water per gallon of gasoline-equivalent average). Water efficiency at ethanol production facilities has been improving, but withdrawals from confined aquifers may still be a problem in certain locations.

The effects of increasing biofuel production on soil and biodiversity can be positive or negative depending on feedstock type and management practices used. Thus, the effects of achieving RFS2 on those two environmental variables cannot be readily quantified or qualified largely because of the uncertainty in the future.

Thank you for the opportunity to testify. I would be happy to answer any questions the Subcomittee might have.

Chairman HALL. Thank you. She yields back her time.

We now recognize our third witness, Margo Oge, from the Environmental Protection Agency.

STATEMENT OF MS. MARGO OGE, DIRECTOR, OFFICE OF TRANSPORTATION AND AIR QUALITY, U.S. ENVIRONMENTAL PROTECTION AGENCY

Ms. OGE. Thank you, Mr. Chairman Hall, Ranking Member Congressman Miller, and the Members of the Subcommittee. I want to thank you for giving me the opportunity to appear before you today to testify and hopefully clear the record on a number of issues that were raised earlier.

I will begin with a very brief overview of the Renewable Fuel Standards Program. The Energy Independence and Security Act established renewable fuel standards for the transportation fuel of 36 billion gallons by 2022. This includes 16 billion gallons of advanced biofuels.

Each year the law directs EPA to establish annual volume standards that refiners must meet the following year. To do this, we conduct an extensive transparent evaluation of the state of the renewable fuel industry and at the same time we also consult with our colleagues at the Department of Energy and Department of Agriculture.

To give you an example, for 2011, this review resulted in EPA lowering the volume for cellulosics to six million gallons, substantially below what the Clean Air Act was requiring, which was 250 million gallons for 2011. This was due to the limited production capacity of the industry. For 2012, we propose a range of 3.5 to 12.9 million gallons, and we will finalize the final standards by sometime this fall.

Let me say a few words, please, about E15 in gasoline. Under the Clean Air Act, companies that produce fuels cannot increase the concentration of ethanol in gasoline unless the administrator of EPA provides a waiver. The law provides for waivers when EPA determines that the increased concentration of ethanol will not

cause or contribute to failure of vehicles or engines to meet emission standards.

In 2010, we received a waivers request from Growth Energy for E15 gasoline. We sought in review in a very transparent way all the available evidence, including extensive data developed by the Department of Energy, by industry, and other organizations. Based on the available information we granted a partial waiver, allowing 15 percent of ethanol to be used in model years 2001 and in newer vehicles but prohibited, and I want to underline prohibiting the use for older vehicles and off-road equipment, including marine engines.

We also placed several conditions on the waivers to reduce the potential for misfueling with E15, including labeling pumps dispensing E15, tracking E15 distribution, and requiring retail stations to survey. As a new gasoline, E15 must be registered under the Clean Air Act before it is marketed. Today E15 is not registered. Industry has given us a sufficient date for us to evaluate it, but we still have not registered E15.

The last topic that I would like to cover is the development of the so-called Tier 3 standards. Let me explain to you what Tier 3 means. This refers to the potential new standards for clean vehicles and fuels to address basically the Nation's clean air goals.

As you know, motor vehicles and their fuels are an important source of compounds that form air pollution. In 2008, 120 million people still lived in counties that exceeded the public health-based standards. In many of these areas motor vehicles contribute anywhere from five percent to 45 percent of specific pollutants.

When EPA established the Public Health Standard for ozone in 2008, under the previous Administration, the Regulatory Impact Analysis for this existing ozone standard included the so-called Tier 3 standards that we are talking about today, which is cleaner cars and cleaner fuel. And the reason for that was to help States and localities to meet the clean air goals of the existing ozone acts in a cost-effective way.

Now, as we develop this proposal, we are considering vehicle and fuel as an integrated system. You know, this will enable us to optimize fuel and vehicle changes, finding the lowest cost in technical, feasible, and emission reductions. As lead in gasoline, we know that sulfur in gasoline degrades the performance of catalysts, and by doing that we are reducing the ability of catalysts to address emissions.

So lowering the sulfur in gasoline would make emission control technology more effective, not just for new vehicles but also for the existing fleet, and the end result would be cleaner air.

Thank you for the opportunity to testify, and I am looking forward to answer any questions that you may have.

[The prepared statement of Ms. Oge follows:]

PREPARED STATEMENT OF MS. MARGO OGE, DIRECTOR,
OFFICE OF TRANSPORTATION AND AIR QUALITY,
U.S. ENVIRONMENTAL PROTECTION AGENCY

Chairman Harris, Ranking Member Miller, and Members of the Committee, I appreciate the opportunity to appear before you today to testify on various transportation fuel-related programs under the Clean Air Act (CAA), as amended by the Energy Independence and Security Act of 2007 (EISA). As requested, I will discuss

three different fuels issues: the renewable fuel standards; partial waivers allowing the introduction into commerce of gasoline containing up to 15 percent ethanol (E15) for use in MY2001 and newer light-duty motor vehicles (which include passenger cars, light-duty trucks and medium-duty passenger vehicles), and potential future controls on vehicles and fuel quality, known as "Tier 3" standards.

Renewable Fuel Standards

On March 26, 2010, the Environmental Protection Agency (EPA) finalized regulations to implement the updated national renewable fuel standard program (RFS) required by Congress under EISA in 2007. These provisions established new year-by-year specific volume standards for the amount of renewable fuel that must be used in transportation fuel, with the standards requiring a total of 36 billion gallons by 2022. This total includes 21 billion gallons of advanced biofuels, composed of 16 billion gallons of cellulosic biofuel, four billion gallons of "other" advanced biofuels, and a minimum of one billion gallons of biomass-based diesel. The new requirements also include new definitions and criteria for both renewable fuels and the feedstocks used to produce them, including new greenhouse gas emission (GHG) thresholds. EPA applied the best available science, and conducted extensive analyses to implement these complex and challenging statutory provisions. The regulatory requirements went into effect on July 1, 2010, and apply to domestic and foreign production of renewable fuels used in the United States.

We estimate the RFS program, when fully implemented, would displace about 13.6 billion gallons of petroleum-based gasoline and diesel fuel, which represents about seven percent of expected annual gasoline and diesel consumption in 2022. We also estimate that the fully implemented program would decrease oil import expenditures by $41.5 billion dollars, result in additional energy security benefits of $2.6 billion, and reduce GHG emissions by an average annualized rate of 138 million metric tons of CO_2 equivalent per year.

EPA supports expanded use of advanced biofuels, especially cellulosic biofuels, which must achieve at least a 50% and a 60% reduction, respectively, in lifecycle greenhouse gases. As directed, each year EPA publishes the annual volumetric requirements for total, advanced, biomass-based diesel, and cellulosic renewable fuels that refiners must meet the following year. As part of this effort, EPA must determine the projected volume of cellulosic biofuel production for the following year and, if this is less than the volume specified in the statute, EPA must lower the standard accordingly. In developing proposed annual volume standards, we conduct a rigorous investigation of the cellulosic industry, including one-on-one discussions with each producer to determine their production potential for the following year. EPA also consults directly with the Department of Agriculture and the Department of Energy, including the Energy Information Administration (EIA) to determine the status of production capacity and capabilities of the cellulosic sector. These evaluations are based on evolving information about emerging segments of the biofuels industry and may result in applicable volumes that are different from those in the statute. We propose the annual volume standards through a transparent rulemaking process, allowing for public review and comment, prior to finalizing the standards. This process ensures the most robust determination possible at the time the standards are set.

In 2010 and 2011, as a result of limited production capacity, we found it necessary to reduce the cellulosic standard to about 6.5 and 6 million gallons, respectively, substantially below the CAA targets of 100 and 250 million gallons for those years. For 2012, we proposed a range of 3.5 to 12.9 million gallons. We will finalize the volume standards later this fall. Under the statute, if we lower the cellulosic standard, EPA has discretion to reduce the total advanced and total renewable fuel standards. Thus far, we have not found cause to reduce the overall advanced and renewable standards.

EPA also recognizes the importance of evaluating and qualifying new biofuels for use in the RFS program. We already have a long list of qualified advanced and cellulosic biofuels approved in the current RFS, including biodiesel and renewable diesel from certain feedstocks, ethanol from sugarcane, diesel from algal oil, ethanol and diesel from approved cellulosic feedstocks, and jet fuel and heating oil from certain feedstocks. In addition, we have established a process to evaluate new biofuel pathways for approved use in the RFS program and are using this process to qualify new fuel pathways that can support meeting the future standards. Many of the feedstocks or biofuels undergoing evaluation are under consideration as new advanced biofuels. These include ethanol, diesel and gasoline produced from renewable feedstocks like energy cane, camelina, and arundo donax, to name only a few.

E15 Waiver

Under the Clean Air Act, companies that produce fuels cannot increase the concentration of ethanol in gasoline for use in gasoline-fueled vehicles unless the Administrator waives this restriction by determining that the increased concentration will not cause or contribute to the failure of vehicles or engines to meet emissions standards. E10 (gasoline with 10% ethanol by volume) was granted a waiver by operation of law under a previous version of CAA section 211(f)(4) more than 30 years ago. It is now ubiquitous in the marketplace, with E10 blends now accounting for over 90 percent of the total U.S. gasoline market.

In 2010, EPA granted in part and denied in part an application from Growth Energy and 54 ethanol producers requesting a waiver that would increase the permissible concentration of ethanol in gasoline to 15 percent. Based on the available evidence, including extensive test data developed by the Department of Energy (DOE) and other researchers, EPA determined that the CAA criterion in section 211(f)(4) was met for allowing E15 to be introduced into commerce for use in model year (MY) 2001 and newer light-duty motor vehicles, which includes passenger cars, light-duty trucks and medium-duty passenger vehicles. EPA also found that E15 did not meet the statute's criterion in the case of motor vehicles older than MY2001 and other types of vehicles and gasoline-powered equipment. As a result, EPA granted partial waivers raising the permissible concentration of ethanol in gasoline to 15 percent for use in MY 2001 and newer light-duty motor vehicles, but not for use in any other gasoline-powered vehicles or engines such as lawnmowers and boats.

EPA placed several conditions on the waivers to reduce the potential for misfueling with E15. As a result, fuel producers that decide to introduce E15 into commerce must take a number of steps designed to reduce misfueling, including labeling pumps dispensing E15, tracking E15 distribution on product transfer documents and conducting retail station surveys. To further mitigate the potential for misfueling, EPA also issued regulations that apply more broadly, to fuel marketers as well as fuel producers, and that prohibit anyone, including consumers, from misfueling with E15.

As a new gasoline, E15 must be registered under the Clean Air Act before it may be introduced into commerce for use in MY2001 and newer light-duty motor vehicles. Earlier this year, ethanol industry representatives submitted emissions and health effects information for use in completing registration applications for E15. They are now developing additional information for that purpose. Once complete, the information will be helpful to fuel producers in submitting registration applications for E15. Until such time as EPA approves a complete registration application, E15 may not be lawfully sold for use in MY2001 and newer light-duty motor vehicles.

Tier 3

The last topic I will cover is development of what is commonly referred to as the "Tier 3" vehicle and fuel standards. Emissions from motor vehicles and their fuels contribute to ozone, particulate matter (PM), nitrogen dioxide (NO_2), and carbon monoxide (CO), which are all pollutants for which EPA has established health-based National Ambient Air Quality Standards (NAAQS). In 2008, over 120 million people lived in counties that exceeded the health-based standards then in effect.

Motor vehicles are an important source of the compounds that form this air pollution. We project that in many nonattainment areas, cars and light trucks will contribute 15–45% of total nitrogen oxides emissions; 10–25% of total volatile organic compound emissions, and 5–10 percent of total emissions of fine particulate matter. When a revised health-based standard for ozone was set in 2008, the Regulatory Impact Analysis for the new standard included potential Tier 3 standards as part of an overall assessment of measures that would help States meet the ozone standard.

The Clean Air Act authorizes EPA to establish emissions standards for motor vehicles to address air pollution that may reasonably be anticipated to endanger public health or welfare. EPA also has authority to establish fuel controls where emissions products of gasoline may reasonably be anticipated to endanger public health or welfare or where they significantly impair motor vehicle emissions control devices or systems.

In the decade since we set the Tier 2 vehicle and fuel standards, there have been advancements in vehicle catalyst technology and computer control technology that should enable significant, cost-effective reductions in motor vehicle tailpipe emissions. Tier 3 vehicle and fuel standards have the potential to cost-effectively reduce NO_2, PM, and VOCs by hundreds of thousands of tons.

As we develop this proposal, we are considering the vehicle and its fuel as an integrated system, which would enable technologically feasible and cost-effective emission reductions beyond what would be possible looking at vehicle and fuel standards in isolation. We first applied such an approach with our Tier 2 vehicle/gasoline sulfur standards, finalized in 2000. We believe that a similar approach in the Tier 3 proposal would be a cost-effective way to achieve substantial additional emissions reductions.

There are extensive data showing that gasoline sulfur degrades the performance of catalytic systems that are key to reducing emissions from gasoline vehicles. Lowering the sulfur content of gasoline would make emission control technologies more effective for both existing and new vehicles. Gasoline sulfur reductions would be a key factor in enabling manufacturers to comply across the vehicle fleet with the new standards, while also achieving immediate significant benefits by reducing emissions from the existing vehicles.

The Agency has been talking to diverse stakeholders as we develop a proposal for Tier 3 vehicle and fuel standards that would reduce emissions from passenger cars and light-duty trucks. The Alliance of Automobile Manufacturers has urged the Agency to harmonize vehicle emissions standards with the State of California's program, thus allowing manufacturers to design a single vehicle for nationwide sales. New Tier 3 vehicle and fuel standards would create a comprehensive program for regulating motor vehicles and fuels that would provide regulatory certainty and compliance efficiency for auto manufacturers. The Tier 3 proposal will also address a number of requests from fuel industry representatives to streamline fuels regulations during the retrospective regulatory review process conducted in response to the President's Executive Order on January 18, 2011.

The Clean Air Act

These fuel programs are part of, or would continue, the 40-year Clean Air Act success story. For 40 years, the Clean Air Act has allowed steady progress to be made in reducing the threats posed by pollution and allowing us all to breathe easier. In the last year alone, programs implemented pursuant to the Clean Air Act Amendments of 1990 are estimated to have reduced premature mortality risks equivalent to saving over 160,000 lives; spared Americans more than 100,000 hospital visits; and prevented millions of cases of respiratory problems, including bronchitis and asthma.[1] They also enhanced productivity by preventing 13 million lost workdays; and kept kids healthy and in school, avoiding 3.2 million lost school days due to respiratory illness and other diseases caused or exacerbated by air pollution.[2]

However, few of the emission control standards that gave us these huge gains in public health were uncontroversial at the time they were developed and promulgated. Most major rules have been adopted amidst claims that that they would be bad for the economy and bad for employment.

Some may find it surprising that the Clean Air Act also has been a good economic investment for our country. In contrast to doomsday predictions, history has shown, again and again, that we can clean up pollution, create jobs, and grow our economy all at the same time. Over that same 40 years since the Act was passed, the Gross Domestic Product of the United States grew by more than 200 percent.[3]

Some would have us believe that "job-killing" describes EPA's regulations. It is misleading to say that enforcement of the Clean Air Act is bad for the economy and employment. It isn't. Families should never have to choose between a job and healthy air. They are entitled to both.

The EPA's updated public health safeguards under the Clean Air Act will encourage investments in labor-intensive upgrades that can put current unemployed or under-employed Americans back to work. Environmental spending creates jobs in engineering, manufacturing, construction, materials, operation, and maintenance. For example, EPA vehicle emissions standards directly sparked the development and application of a huge range of automotive technologies that are now found throughout the global automobile market. The vehicle emissions control industry employs approximately 65,000 Americans with domestic annual sales of $26 bil-

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[1] USEPA (2011). The Benefits and Costs of the Clean Air Act from 1990 to 2020. Final Report. Prepared by the USEPA Office of Air and Radiation. February 2011. Table 5-5. This study is the third in a series of studies originally mandated by Congress in the Clean Air Act Amendments of 1990. It received extensive peer review and input from the Advisory Council on Clean Air Compliance Analysis, an independent panel of distinguished economists, scientists, and public health experts.

[2] Ibid.

[3] Bureau of Economic Analysis, National Economic Accounts, "Table 1.1.5. Gross Domestic Product," *http://bea.gov/national/index.htm#gdp*.

lion.[4] Likewise, in 2008, the United States' environmental technologies and services industry 1.7 million workers generated approximately $300 billion in revenues and led to exports of $44 billion of goods and services,[5] larger than exports of sectors such as plastics and rubber products.[6] The size of the world market for environmental goods and services is comparable to the aerospace and pharmaceutical industries and presents important opportunities for U.S. Industry.[7]

Conclusion

Thank you for the opportunity to testify today.

Chairman HALL. Thank you. The gentlelady yields back her time.

I now recognize our fourth witness, Dr. Jay Kesan, from the University of Illinois College of Law, for five minutes.

Mr.MILLER. You need to turn your microphone on.

STATEMENT OF DR. JAY KESAN, PROFESSOR AND H. ROSS AND HELEN WORKMAN RESEARCH SCHOLAR AND PROGRAM LEADER OF THE BIOFUEL LAW AND REGULATION PROGRAM, ENERGY BIOSCIENCES INSTITUTE, UNIVERSITY OF ILLINOIS COLLEGE OF LAW

Mr. KESAN. Okay. Sorry. Good afternoon, Chairman Hall, Ranking Member Miller, and Members of the Committee. Thank you for the opportunity to appear before you.

My name is Jay Kesan. I am a Professor at the University of Illinois and Program Leader of the Biofuel Law and Regulation Program at the Energy Biosciences Institute, which is a joint effort between the University of Illinois, the University of California, Berkeley, and the Lawrence Berkeley National Laboratory and which has been funded by BP as a multi-year research commitment.

In 2005, the U.S. Congress passed the Energy Policy Act, which charged the EPA with developing and implementing the Renewable Fuel Standard Program. This program was significantly altered in 2007, with the passage of the Energy Independence and Security Act, and this expanded program is commonly referred to as RFS2.

There were three main policy goals that drove the RFS legislation; national energy security, reduction in GHG emissions, and economic development, particularly in the rural sector. All three of these drivers are definitely still with us today and will continue to remain important in the foreseeable future.

Under the RFS Program gasoline producers and importers, not the government and consumers, are responsible for introducing renewable biofuel into the U.S. market. In essence, the policy instrument of the RFS is a mandatory demand regime that requires the

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[4] Manufacturers of Emissions Control Technology (*http://www.meca.org/cs/root/organization*$_{2info/who-we-are}$).

[5] DOC International Trade Administration. "Environmental Technologies Industries: FY2010 Industry Assessment," *http://web.ita.doc.gov/ete/eteinfo.nsf/068f3801d047f26e85256883006ffa54/4878b7e2fc08ac6d85256883006c452c/$FILE/Full%20Environmental%20Industries%20Assessment%202010.pdf* (accessed February 8, 2011).

[6] U.S. Census Bureau, Censtats Database, International Trade Data—NAICS, *http://censtats.census.gov/naic3_6/naics3_6.shtml (accessed September 6, 2011).*

[7] Network of Heads of the European Environment Protection Agencies, 2005. "The Contribution of Good Environmental Regulation to Competitiveness," *http://www.eea.europa.eu/about-us/documents/prague_statement/prague_statement-en.pdf (accessed February 8, 2011).*

regulated parties to commercialize more renewable fuel than the amount the market would achieve in the absence of the RFS.

So how does such a large-scale mandatory demand regime like the RFS help reduce production costs of renewable biofuel over time? This is well understood by conventional economic theory. The possibility of large-scale mandatory consumption allows renewable biofuel producers and their feedstock suppliers to operate at a large scale through economies of scale and/or Marshallian externalities.

Second, the RFS2 Program induces biofuel producers and their feedstock suppliers to invest in R&D activities creating cost-saving innovation.

Our empirical work has shown that ethanol plants in the past decade have actually contributed through the RFS to increasing economies of scales and to improving the level of competition among firms through existing plant expansion as well as expansion through new plant construction.

Finally, uncertainty influences investment decisions regarding R&D activity. Hence, removing some degree of the uncertainty by creating several years of a mandatory demand regime makes it easier for biofuel producers to finance their R&D projects. The uncertainty and risk of an unstable policy have an even bigger impact on commercial investments because the costs are so much higher compared to R&D. On the other hand, a stable commitment to an RFS2 regime reduces that uncertainty and risk associated with commercial investments.

Other regulatory initiatives such as E15 and E85 work in tandem with RFS2 to facilitate innovation and development of the biofuel industry. In addition, efforts to clarify regulations by removing some of the uncertainty about the approved level of blending for biobutanol is another initiative that works with the RFS2 Program to further expand the development of advanced biofuels such as biobutanol.

We are in an era of heavily constrained government spending. Policy initiatives like the RFS do not require government money. Rather, RFS facilitates innovation and commercialization of new technologies by reducing some uncertainties by providing a guarantee of market demand.

We are starting to see the RFS program begin to yield tangible results on the ground in terms of producing advanced biofuels and cellulosic biofuels. For instance, the commercial investments in biofuels derived from lignocellulosic biomass are real. There are credible players in the industry such as INEOS, Abengoa, POET and BP breaking ground on new plants and projects.

I am an engineer and a lawyer, but my esteemed colleagues at the Energy Biosciences Institute, who are world-class experts in the plant sciences, tell me that scientific advancements have already solved the problem of obtaining sugar from lignocellulosic biomass many times. Therefore, it is only a matter of technological effort and time, together with the support of a foundational policy like the RFS, before we see large-scale production of advanced biofuels.

There is extensive research showing that learning by doing lowers the production cost of biofuels. This has been shown to be true for corn ethanol and sugarcane ethanol. The RFS is a cornerstone

piece of legislation for the biofuel industry. The RFS mandates will accelerate the production of advanced biofuels and lead to more cumulative experience and promote the innovation needed to lower production costs in the future.

We need a broad-based approach to energy policy in the U.S., and biofuels will play a significant role in our national energy portfolio. We need important policy mechanisms like the RFS to ensure that we have new energy options. A healthy market is one that has a broad set of biofuel producers and, more importantly, a diverse portfolio of renewable energy options.

Thank you very much for your attention. I am happy to answer any questions that the Members of the Committee may have.

[The prepared statement of Dr. Kesan follows:]

PREPARED STATEMENT OF DR. JAY KESAN, PROFESSOR AND H. ROSS AND HELEN WORKMAN RESEARCH SCHOLAR AND PROGRAM LEADER OF THE BIOFUEL LAW AND REGULATION PROGRAM, ENERGY BIOSCIENCES INSTITUTE, UNIVERSITY OF ILLINOIS COLLEGE OF LAW

Good afternoon, Chairman Harris, Ranking Member Miller, and Members of the Committee. Thank you for the opportunity to appear before you.

Introduction

My name is Jay Kesan. I am a Professor at the University of Illinois at Urbana-Champaign and the Program Leader of the Biofuel Law and Regulation Program at the Energy Biosciences Institute, a joint research effort between the University of Illinois, the University of California, Berkeley, and the Department of Energy's Lawrence Berkeley National Laboratory, and funded by BP as a multi-year research commitment.

The Renewable Fuel Standard (RFS) Program

In 2005, the U.S. Congress passed the Energy Policy Act, which charged the Environmental Protection Agency (EPA) with developing and implementing the Renewable Fuel Standard Program (RFS). The RFS was designed to ensure the introduction and consumption of a certain volume of renewable fuel in the Unites States. More specifically, under the RFS Program, obligated parties such as gasoline producers and importers were required to produce or purchase a specific amount of renewable biofuel every year between 2006 and 2012.

The RFS was significantly altered in December 2007 with the passage of the Energy Independence and Security Act of 2007, and the expanded Program is now commonly known as RFS2. Under the RFS2, the period of volumetric requirements is extended through 2022, and renewable fuel is sub-categorized into traditional renewable fuel, advanced biofuel, cellulosic biofuel, and biomass-based diesel based on fuels' feedstocks and the green house gas (GHG) emission reduction thresholds that they satisfied.

There were three main policy goals that drove the RFS legislation—national energy security, reduction in GHG emissions, and economic development, particularly in the rural sector. All three of these drivers are definitely still with us today and will continue to remain important in the foreseeable future.

The Economic Rationales for the RFS2 Program

The RFS program is designed to facilitate the substitution process of domestically produced, renewable biofuels for petroleum, and to make renewable fuel economically viable in the future. In order to achieve this main goal, gasoline producers and importers are required to commercialize their obligated amount of renewable biofuel every year during the period between 2006 and 2022. These parties—not the government and consumers—are responsible for introducing renewable biofuel into the U.S. market. In essence, the policy instrument of the RFS is a mandatory demand regime that requires gasoline producers and importers to commercialize more renewable biofuel than the amount the market would achieve in the absence of the RFS.

How does such a large-scale mandatory demand regime like the RFS help reduce production costs of renewable biofuel over time? This is well understood, and several mechanisms can be found in light of well-established economic theory. First, economies of scale and/or Marshallian externality contribute to improving production cost conditions. A possibility of large-scale mandatory consumption allows renewable biofuel producers and their feedstock suppliers to operate at a large scale. Then, large-scale operation decreases their average cost of production. In particular, when the fixed cost of physical capital is very high, this effect is likely to kick in. High fixed costs are not limited to physical capital, and they may equally apply to R&D expenditures. Thus, large-scale demand raises the profitability from R&D activity, and, as a result, promotes technological advancement. Similarly, large-scale mandatory demand improves the infrastructure of the renewable biofuel industry. This externality positively affects the cost conditions of each producer involved in the biofuel industry.

Second, the RFS2 program induces biofuel producers and their feedstock suppliers to invest in R&D activities creating cost-saving innovation. The basic logic of this relies on the well-established idea of "market pull" or "cost spreading." In the context of the RFS program, a renewable biofuel producer reaps the benefits of cost-saving innovation by embedding them in biofuel technology and then selling biofuel as a final product. While his R&D expenditures are a fixed cost, the marginal benefit from such R&D is proportional to biofuel sales. That is, the producer benefits more from cost-saving innovation as its sales increase. Thus, the possibility of large-scale biofuel sales, brought about by the RFS, gives biofuel producers an extra incentive to invest in the R&D that creates cost-saving innovation. In addition, large-scale mandatory consumption provides incentives to new market entrants. Therefore, higher levels of market competition require more cost-saving innovation in order to survive. In such cases, technological advancement might not necessarily come with a larger scale of production. However, it is surely the case that costs are lower with improved production technology.

Our empirical work analyzing ethanol plants in the past decade indicates that the RFS has contributed to increasing economies of scale and to improving the level of competition among firms through existing plant expansion as well as expansion through new plant construction. [1]

Finally, uncertainty influences investment decisions regarding R&D activity. In general, returns to R&D investments are quite skewed, and firms may find it difficult to finance R&D expenditures through the capital market. Thus, removing some degree of uncertainty by creating several years of a mandatory demand regime makes it easier for biofuel producers to finance their R&D projects. Furthermore, according to option value theory, firms may postpone R&D projects because of great uncertainty even if the net present value of the project is not negative. As mentioned previously, the returns to R&D investments partly depend on demand conditions. Since the mandatory demand of the RFS guarantees a market to biofuel producers, it reduces the degree of uncertainty. This in turn leads to lowering discount factors associated with uncertainty of benefits derived from R&D projects. In sum, the RFS encourages R&D activity in the industry by easing credit constraints or lowering the value of postponing R&D projects.

The amount of money spent on R&D is lower than the amount of money that biofuel producers need to spend to build commercial production facilities, and thus the uncertainty and risk of an unstable policy has an even bigger impact on commercial investments because the costs are so much higher. On the other hand, a stable commitment to the RFS2 regime reduces that uncertainty and risk associated with commercial investments.

Other regulatory initiatives such as the E15 and E85 programs work in tandem with the RFS2 to facilitate innovation and further development of the biofuel industry. In addition, efforts to clarify regulations by removing some of the uncertainty about the approved level of blending for biobutanol is another positive initiative that can work with the RFS2 Program and further expand the development of advanced biofuels such as biobutanol.

Consider another example from another renewable energy sector—the case of wind energy. I have attached a graph to my written statement that shows that investment in wind energy has been stable and growing rapidly in the past decade whenever there has been a stable tax policy in place. This once again illustrates the importance of a firm and stable policy commitment instead of intermittent policy initiatives.

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[1] J.P. Kesan, A. Ohyama, and H.-S. Yang, "An Economic Evaluation of the Renewable Fuel Standard (RFS) Standard Program: An Industrial Policy Approach," Working Paper, available on SSRN, *http://www.ssrn.com* (2011).

We are in an era of heavily constrained government funding. Policy initiatives like the RFS mandates do not require government money. Rather, we are simply facilitating innovation and commercialization of new technologies by reducing some uncertainties by providing a guarantee of market demand.

It is worth noting that similar regulatory regimes in other arenas designed to advance and facilitate the development and deployment of new technologies have a long and successful history. Such examples include automobile airbag technology, digital broadcasting, enhanced 911 calling and the like.

Taking Stock of Where We Are Today and Looking Ahead

We are starting to see the RFS program begin to yield tangible results on the ground in terms of producing advanced biofuels and cellulosic biofuels. For instance, the commercial investments in biofuels derived from lignocellulosic biomass are real. There are credible players in the industry such as INEOS, Abengoa, POET and BP breaking ground on new plants and projects this year and in 2010.

I am an engineer and a lawyer. But my esteemed colleagues at the Energy Biosciences Institute (EBI), who are world-class experts in the plant sciences, tell me that scientific advancements have already solved the problem of obtaining sugars from lignocellulosic biomass many, many times. Therefore, it is now only a matter of technological effort and time, together with the encouragement and support of a foundational policy such as the RFS, before we achieve large-scale production of advanced biofuels.

Relatedly, the U.S. has a substantial land base beyond that used for row-crop agriculture that can be mobilized to achieve substantial domestic biofuel production and meet all the biofuel mandates of EISA/RFS2. [2]

There is extensive research showing that "learning by doing" lowers the production cost of biofuels. This has been shown to be true for corn ethanol and sugarcane ethanol. The RFS is a cornerstone piece of legislation for the biofuel industry. The RFS mandates will accelerate the production of advanced biofuels and lead to more cumulative experience and promote the innovation needed to lower production costs in the future.

The National Research Council report on the RFS is not a conclusion on the biofuel industry and is, more accurately, a report on a work that is still in progress. In fact, the NRC report is based on rather outdated information. For instance, it is not based on current biomass production estimates or on current technological information. That said, the NRC report does correctly acknowledge that commercializing advanced and cellulosic biofuel technologies will require policy certainty.

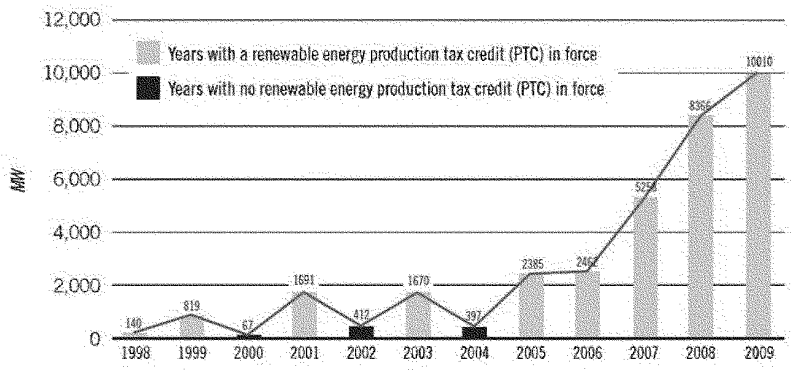
We need a broad-based approach to energy policy in the U.S. and biofuels will play a significant role in our national energy portfolio. We need important policy mechanisms such as the RFS to ensure that we have new energy options. A healthy market is one that has a broad set of biofuel producers and, more broadly, a diverse portfolio of renewable energy options, including solar, wind, natural gas, hydroelectricity, and biofuels.

Thank you very much for your attention. I am happy to answer any questions that Members of the Committee may have.

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[2] C. Somerville, H. Youngs, C. Taylor, S.C. Davis, and S.P. Long, "Feedstocks for Lignocellulosic Biofuels," *Science*, vol. 329, pp. 790–792 (13 Aug. 2010); Huang, H., M. Khanna, and X. Yang, "Economic Implications of Energy Crop Production on Conservation Reserve Program (CRP) Land" presentation at AFRI Meeting on *Prosperity for Small- and Medium-Sized Farms and Rural Communities Programs*, Miami, Florida, November 7–9, 2011.

Net Annual Installed Wind Power Capacity in the United States, 1998–2009



Source: American Wind Energy Association

Chairman HARRIS. Thank you very, very much.

I now recognize our fifth witness, Mr. Bob Greco of the American Petroleum Institute.

STATEMENT OF MR. BOB GRECO, GROUP DIRECTOR, DOWNSTREAM AND INDUSTRY OPERATIONS, AMERICAN PETROLEUM INSTITUTE

Mr. GRECO. Thank you. Good afternoon, Mr. Chairman, Ranking Member Miller, and other Committee Members. My name is Bob Greco, and I am the Downstream Group Director for the American Petroleum Institute, API. Thank you for the opportunity to testify on the conflicts and unintended consequences of motor fuels, particularly the Tier 3 requirements now being developed by EPA.

API represents over 480 member companies involved in all aspects of the oil and natural gas industry, an industry that supplies most of America's energy, supports 9.2 million U.S. jobs and 7.5 percent of the U.S. economy, and has invested nearly $2 trillion dollars in U.S. capital projects since 2000, including those spurring advances in nearly every formable form of energy.

The U.S. refining industry already operates in an extremely complex regulatory environment. U.S. refiners have invested $112 billion in environmental improvements between 1990 and 2008, significantly reducing emissions while producing cleaner fuels and improving energy efficiency.

On top of these existing regulations, U.S. refiners are now facing a blizzard of significant and potentially very costly regulations that may take effect over the next few years. These regulations include more stringent Tier 3 standards; refinery controls including greenhouse gas limitations through the new NESHAP and NSPS requirements; the RFS implementation and the impending blend wall; refinery emissions controls to achieve more stringent air quality standards for ozone, particulate matter, and other pollutants; and new EPA requirements for boilers and incinerators.

Today I will focus on the proposed Tier 3 gasoline standards being drafted by EPA.

Under the Clean Air Act, EPA has already implemented stringent rules reducing the amount of sulfur allowed in gasoline and reducing vapor pressure. For example, the Tier 2 rules have reduced sulfur levels in gasoline by 90 percent, from an average of 300 parts per million before 2004 to an average of 30 parts per million today. EPA is now developing a Tier 3 rulemaking that would reduce sulfur levels to an average of 10 parts per million, nearly a 70 percent change from today's already low levels, while also reducing gasoline volatility and perhaps other properties.

EPA expects to issue a proposed rule by the end of this year and a final rule in 2012. EPA should not issue a Tier 3 proposal without first justifying the impacts, costs, and benefits of further reducing sulfur and vapor pressure. EPA has not produced a scientific basis to justify these new regulations, and at this point EPA has not released the date of the agency claims to have already in hand.

We have studied and believe that further sulfur and vapor pressure reductions would not produce benefits enough to justify the potentially onerous costs. These could include higher fuel manufac-

turing costs, refinery closures, lost jobs, increased emissions, and increased product imports.

Researchers at Baker and O'Brien have studied the costs and impacts of several Tier 3 scenarios which could require a substantial reconfiguration of U.S. refineries. Their research shows that the refining industry could face up-front capital costs ranging from between $10 to $17 billion, with recurring annual costs in the range of $5 to $13 billion.

As a result, they contend, gasoline manufacturing costs could rise by up to 25 cents a gallon.

In addition, up to 14 percent of total gasoline production volume could be lost. This volume would suffer when sulfur is reduced and light-end components are removed from gasoline.

Finally, because the processes used to reduce sulfur content and vapor pressure are also energy intensive, they could increase refinery carbon dioxide emissions by up to 2.3 percent. EPA would thus needlessly put upward pressure on refineries to increase their CO_2 emissions while separately proposing requirements to reduce their CO_2 emissions.

Overall, this research estimate said up to seven U.S. refineries could close, as they would be unable to make or recover the required investments to comply with the new requirements. This would be in addition to the 66 U.S. refineries that have already closed in the last 20 years. The U.S. Department of Energy has identified the cost of regulatory compliance as a part of the economic stress that caused the shutdowns. The regulatory burden of Tier 3 requirements could add to that stress.

In conclusion, America's refining industry is a strategic and valuable asset that provides U.S. with secure supplies of fuel products and directly and indirectly employs nearly 500,000 Americans. It is already heavily regulated. Layering on new regulations is hard to understand when our economy is already not generating jobs, and then the Administration says it looks for ways to limit unnecessary or inefficient regulations.

In the interest of more transparency in government and sounder regulations, we urge the agency to perform the needed studies and analysis and release all other pertinent information to stakeholders before going forward with the Tier 3 requirements.

Thank you for your time today, and I look forward to your questions.

[The prepared statement of Mr. Greco follows:]

PREPARED STATEMENT OF MR. BOB GRECO, GROUP DIRECTOR, DOWNSTREAM AND INDUSTRY OPERATIONS, AMERICAN PETROLEUM INSTITUTE

Good afternoon. My name is Bob Greco, and I am Group Director of Downstream and Industry Operations for the American Petroleum Institute (API). Thank you for the opportunity to testify today on overlapping and sometimes contradictory fuel requirements facing the refining industry. API is a national trade association representing over 480 member companies involved in all aspects of the oil and natural gas industry.

U.S. Refining Is a Strategic Asset

America's refiners are a strategic asset for the United States, and maintaining a viable domestic refining industry is critical to the Nation's economic security. The refining industry provides the fuels that keep America moving. The industry pro-

vides the Nation's military with secure, available fuels wherever and whenever they are required. In addition, it provides affordable and clean fuels products to industries that rely on those fuels to manufacture hundreds of thousands of other consumer products that Americans depend on every single day.

Equally as important, U.S. refineries sustain hundreds of thousands of good-paying, highly skilled American jobs across the country, in addition to the raw material building blocks which support a vast number of other American production industries. According to a study by Wood MacKenzie, the U.S. refining industry employs or supports the employment of over 460,000 jobs in the U.S.

According to the EIA and all credible studies, the United States (and the world) will continue to depend on refining petroleum-based products for decades to come in order to meet the increasing energy demand. Domestic refineries are competing directly with petroleum product imports. Because the refining industry operates on a global basis, the U.S. faces the choice of either manufacturing these products at home or importing them from other countries. The U.S. refining industry already operates in an extremely complex regulatory environment. U.S. refiners have invested $112 billion in environmental improvements from 1990 to 2008, significantly reducing emissions while producing cleaner fuels and improving energy efficiency. Since 2000 alone, U.S. refiners have spent nearly twice as much on environmental improvements as the government and private sector[1] spent on non-hydrocarbon technologies. Regulations governing fuel composition, greenhouse gases, and environmental standards have an enormous financial impact on the refining industry, as do financial controls and taxation.

There are significant and potentially very costly additional regulations under development that may take effect over the next five years. These regulations include:

- More stringent "Tier 3" gasoline standards;
- Refinery controls, including GHG limitations, through new NESHAP and NSPS requirements;
- RFS implementation and the impending "blend wall";
- Refinery emissions controls to achieve more stringent air quality standards for ozone, PM, etc.;
- New EPA requirements for boilers and incinerators (Boiler MACT).

Today I will focus specifically on the proposed Tier 3 gasoline standards being drafted by EPA.

Tier 3 Gasoline Proposal

EPA is developing a "Tier 3" rulemaking that would likely reduce sulfur levels in gasoline to an average of 10 ppm—a nearly 70 percent change from today's already low levels— while also reducing gasoline volatility and, perhaps, other properties. EPA expects to issue a proposed rule by the end of 2011 and a final rule in 2012.

EPA should not issue a Tier 3 proposal without first justifying the impacts, costs, and benefits of reducing sulfur and vapor pressure in gasoline. Although EPA maintains these changes to gasoline are needed to improve air quality and fuel economy, the Agency has not produced the justification to back up its claims. At this point, EPA has not released the data the agency claims to have already in hand.

We have studied and believe that further sulfur and vapor pressure reductions would not produce benefits enough to justify the potentially onerous costs. These could include higher fuel manufacturing costs, refinery closures, lost jobs, increased emissions, and increased product imports.

Under the Clean Air Act, EPA has already implemented increasingly stringent rules reducing the amount of sulfur allowed in gasoline and reducing vapor pressure. For example, the Tier 2 rules have reduced sulfur levels in gasoline by 90 percent, from an average of 300 parts per million before 2004 to an average of 30 parts per million today. EPA has told us that Tier 3 rules would likely require a further reduction to 10 parts per million. The Tier 3 changes EPA envisions could require refiners to install additional hydrotreating and fractionation units, significantly altering their refinery configurations and operations.

Researchers at Baker and O'Brien, Inc., have studied the costs and impacts of several Tier 3 scenarios. The study was shared with EPA, DOE, and EIA a couple months ago. The Baker and O'Brien work shows that the refining industry could face up-front capital costs ranging from between $10 billion to $17 billion, with recurring annual operating costs in the range of $5 billion to $13 billion.

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[1] Excluding expenditures by the oil and natural gas industry.

As a result, they contend, gasoline manufacturing costs could rise between 12 cents per gallon and 25 cents per gallon.

In addition, between seven percent and 14 percent of total gasoline production could be lost. Volume would suffer when sulfur is reduced and light end components are removed from gasoline.

Finally, because the refinery processes needed to reduce sulfur content and vapor pressure are also energy intensive, the Tier 3 rule could increase refinery carbon dioxide emissions by up to 2.3 percent. EPA would thus needlessly put upward pressure on refineries to increase their CO_2 emissions while separately proposing requirements to reduce refinery CO_2 emissions. Refineries would also have to ensure that increased emission of other pollutants resulting from reconfiguring their refineries are properly controlled and permit limits maintained.

Overall, Baker and O'Brien estimate that between four and seven U.S. refineries could close, as they would be unable to make or recover the required investments in plant equipment and operations necessary to comply with the new requirements. This would be in addition to the 66 U.S. refineries that have closed in the last 20 years. The U.S. Department of Energy has identified the cost of compliance with various regulations as a part of the economic stress that caused the shutdowns.[2] The regulatory burden of Tier 3 requirements would add to this stress.

Summary

If America's refining industry is to remain viable, we need a regulatory structure that improves our environment while allowing the industry to remain competitive in the worldwide market. The domestic refining industry's outstanding history of regulatory compliance has made U.S. refineries among the cleanest and most efficient in the world. The industry remains committed to meeting regulatory requirements.

However, government must adopt a more reasonable approach to regulations. For example, it should allow time for existing regulations to reach their full effectiveness before adding new layers of regulation. The high and very real costs of complying with overreaching regulations that have uncertain benefits may weaken the ability of our domestic refining industry to compete with foreign refiners.

EPA's combination of suggested CAFE standards and Tier 3 fuel changes, coupled with potential refinery GHG controls, threatens the existence of U.S. refinery jobs and products. Domestic refining capacity could be reduced, thereby increasing imports and costs.

Specifically regarding the proposed Tier 3 fuel requirements, EPA should complete the long overdue Anti-Backsliding study mandated by EISA (and now two years late), finalize and publish its scientific justification as soon as possible, and allow stakeholders adequate opportunity to review the data and provide input long before the Agency proceeds with a proposed Tier 3 fuel rulemaking. EPA should provide a credible analysis showing that lowering the vapor pressure or sulfur content of gasoline will achieve cost-effective, real emissions reductions, and air quality, health and welfare benefits.

Chairman HARRIS. Thank you very much.

I now recognize our next witness, Mr. David Hilbert of Mercury Marine.

STATEMENT OF MR. DAVID HILBERT, THERMODYNAMIC DEVELOPMENT ENGINEER, MERCURY MARINE

Mr. HILBERT. Good afternoon, Chairman Harris, Ranking Member Miller, other Members of the Subcommittee. It is a pleasure to be here this afternoon. My name is David Hilbert, and I am a Thermodynamic Development Engineer from Mercury Marine, which is a division of the Brunswick Corporation. I am here today to testify on behalf of the NMMA.

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[2] U.S. Department of Energy; Office of Policy and International Affairs. *Small Refinery Exemption Study: An Investigation into Disproportionate Economic Hardship* March 2011 *http://www.epa.gov/otaq/fuels/renewablefuels/compliancehelp/small-refinery-exempt-study.pdf*.

I was the technical leader of a test of E15 blend fuel in three different Mercury outboard engines. This was done under contract to the U.S. Department of Energy and coordinated by NREL.

The test objective was to understand the effects of running a 15 percent ethanol blend on outboard marine engines during 300 hours of wide-open throttle endurance. Three separate engine families were evaluated listed here. Two of each engine were evaluated, one being run on E15, the other being run on E0 or ethanol-free gasoline.

It is important to note two main effects seen in this test of the ethanol-blend fuel. One is that the use of ethanol fuel on these engines increases the operating temperature, which can reduce the strength of the metallic components. The other is that ethanol can cause material compatibility issues with the fuel system components due to the chemical interactions.

So this first slide shows photos of the components from our 9.9 horsepower test engine with E0 components being on the left, E15 on the right. The top photos are the undersides of the pistons, and the lower photo is of the connecting rods which connect with the pistons. You can see the evidence of the heavier carbon deposits which indicates the higher metal temperatures on the E15 engine.

The next slide shows photos of the fuel pump gasket and then the mating check valve that it seals against, again, from the 9.9 horsepower engines, and in general the E15 gasket shows more deterioration, and this occurred to the point where there is actually material that transferred from the gasket to the check valve that it seals against, indicating that the gasket was breaking down as evidenced by the photo in the lower right-hand corner.

The next set of images is from the E15-fueled 300 horsepower supercharged engine, which did not complete the entire endurance test on the E15 fuel. The exhaust valve failed as shown in the photo at the left, which ended the test. Upon disassembly, we found two other valves that were cracked. Metallurgical analysis of these valves show that the failure was due to the elevated metal temperatures.

These photos show a comparison of the pistons and connecting rods from the 300 horsepower supercharged engines, and much like the 9.9 horsepower pistons and connecting rods, these components, again, show evidence of higher operating temperatures as evidenced by the difference in the carbon deposits.

This last set of images I would like to show you are from the 200 horsepower, two-stroke engine that was operated on E15. This engine on E15 fuel did not complete the entire endurance test. It failed the rod bearing, which destroyed the engine, the remnants of which are shown in the upper right-hand corner of the screen. The damage was so severe to this engine that the root cause of the failure could not be fully identified, but it should be noted that two-stroke engines of this architecture mix the fuel and the oil and use that mixture to distribute the oil throughout the rest of the engine. More testing is needed to understand how the ethanol affects this type of lubrication system, as it is not well understood at this time.

So despite the limited nature of this testing, several significant issues were identified. This testing was done on a small sample of engines running only one operating point. In addition to the need

for more two-stroke lubrication system testing, as I just mentioned, more testing is really needed to understand how E15 fuel affects marine engines during other operating conditions. Examples of this would include cold start, hot restart, acceleration, part throttle, et cetera.

And another main effect that needs more investigation is to understand the effect of the fuel on the engines that are stored with fuel in the fuel system over long periods of time, which occurs frequently with our engines.

So what I have presented to you in brief today and what is available in the full report are the results of the limited testing conducted on three of Mercury's outboard engine families. Changes in the fuel formulations and the resulting effects on marine engine operability are of high importance to assure a safe and reliable fleet of marine engines. This study showed how misfueling marine engines currently in use with E15 may cause a variety of issues for owners and can lead to premature engine failure.

Thank you for allowing me the opportunity to testify today.

[The prepared statement of Mr. Hilbert follows:]

PREPARED STATEMENT OF MR. DAVID HILBERT,
THERMODYNAMIC DEVELOPMENT ENGINEER, MERCURY MARINE

Good afternoon, Chairman Harris, Ranking Member Miller, other Members of the Subcommittee.

It is a pleasure to be here this afternoon. My name is David Hilbert, and I am a thermodynamic development engineer for Mercury Marine, a division of the Brunswick Corporation, located in Fond du Lac, Wisconsin. Mercury Marine has been a manufacturer of recreational marine engines continuously since 1939, and currently makes and sells more marine engines than any other manufacturer in the world. I am here today to testify on behalf of the National Marine Manufacturers Association, which represents over 1,500 boat builders, marine engine, and marine accessory manufacturers.

I was the technical leader of a test of E15 blend fuel in three different Mercury outboard engines. These tests were conducted at the Mercury Marine test facility in Fond du Lac in 2010–2011 by Mercury personnel under contract to the U.S. Department of Energy and coordinated by the National Renewable Energy Lab (NREL). The final report was released by the Department of Energy in October 2011.

The objective of these tests was to understand the effects of running a 15% ethanol blend on outboard marine engines during 300 hours of wide-open throttle (WOT) endurance testing—a typical marine engine durability test. Three separate engine families were evaluated. A 9.9 HP carburated four-stroke engine and a 300 HP supercharged electronic fuel-injected (EFI) four-stroke engine represented current products. A 200 HP electronic fuel-injected (EFI) two-stroke engine was chosen to represent the legacy products still in widespread use today. Two engines of each family were evaluated. One test engine was endurance tested on E15 fuel, while a second control engine was endurance tested on ethanol-free gasoline.

The primary point to remember when considering this test is that ethanol, in any blend, is an oxygenator. E10 fuel has 3% oxygen, while E15 fuel has 5%–6% oxygen. On a typical marine engine, this additional oxygen makes the fuel burn hotter, and the higher temperatures can reduce the strength of the metallic components. In addition, ethanol can cause compatibility issues with the other materials in the fuel systems because of the chemical interaction. I would like to show you some photos of the engine components after the endurance testing to illustrate the results of the testing.

We were able to complete the entire 300-hour test running E15 in the 9.9 HP engine. Test results indicated poor running quality, including misfires at the end of the test. The poor run quality caused an increase in exhaust emissions. In addition, there were increased carbon deposits in the engine on the underside of the pistons and on the ends of the rods indicating higher engine temperatures. You can see the difference in the carbon deposits in this photo. Additionally, deterioration of the fuel

pump gasket was evident, likely due to material compatibility issues with the fuel blend. This deterioration of the gasket could lead to fuel pump failure, disabling the engine. The effect on the gasket is shown here.

The 300 HP four-stroke supercharged engine did not complete the endurance test on E15 fuel. The engine encountered a valve failure after 285 hours of endurance testing. As you can see from the photos, one valve broke apart, which ended the test, and two others developed cracks. I should mention that these are high-quality valves constructed of inconel, a high-temperature resistant alloy. Even so, when we did metallurgical analysis on this engine, we found that the cause of these fractures was deteriorated mechanical strength due to high metal temperature. The next photos show a comparison of the pistons and connecting rods from the Verado engine, also indicating that the E15 test engine operated at elevated temperatures.

The 200 HP two-stroke engine using E15 fuel also failed to complete the endurance test. It failed a rod bearing at 256 hours of testing, resulting in catastrophic destruction of the engine. You can see the remains of the bearings in the photos. There was so much damage to the engine that we could not determine the exact cause of failure. It is important to note that two-stroke engines of this architecture mix the fuel and the oil and use that mixture to distribute the oil to the critical interfaces such as the bearings and cylinder walls. Ethanol may have an effect on the dispersion or lubricity of the oil as it is mixed with the fuel. More testing of such engines is necessary to understand the ramifications of an E15 blend fuel on this type of lubrication system, as it is not well understood at this time.

Despite the limited nature of this testing, several significant issues were identified. The testing was done on a small sample of engines running one operating point, wide-open throttle. In addition to the need for more two-stroke lubrication system testing, more testing is needed to understand how E15 fuel affects marine engines during other operating conditions. Examples would include starting, acceleration/deceleration, part-throttle operation, and the effect of E15 fuel on marine engines that are stored with fuel in the system over long periods of time, which occurs regularly with our engines.

What I have presented to you in brief today—and what is available at the NREL Web site in full—are the results of the limited testing conducted on three of Mercury's outboard engine families. Changes in fuel formulations and the resulting effects on marine engine operability are of high importance. This study showed how misfueling marine engines currently in use with E15 may cause a variety of issues for owners and can lead to premature engine failure. Thank you for allowing me the opportunity to testify today.

To see the full report from the testing performed by Mercury Marine on outboard marine engines, please visit the following Web site: *http://www.nrel.gov/docs/fy12osti/52909.pdf*.

To view the companion report from the testing performed by Volvo Penta on sterndrive/inboard marine engines, please visit the following Web site: *http://www.nrel.gov/docs/fy12osti/52577.pdf*.

Chairman HARRIS. Thank you very much, and finally I recognize our final witness, Mr. Jack Huttner, from Gevo.

STATEMENT OF MR. JACK HUTTNER,
EXECUTIVE VICE PRESIDENT,
COMMERCIAL AND PUBLIC AFFAIRS, GEVO, INC.

Mr. HUTTNER. Thank you. Good afternoon, Mr. Chairman and Ranking Member Miller and Members of the Subcommittee. My name is Jack Huttner, Executive Vice President for Commercial and Public Affairs of Gevo, and I appreciate the opportunity to be here today.

Gevo is a Colorado-based renewable chemicals and advanced biofuels company. We are developing cost-competitive biobased alternatives to petroleum and have 56 million gallons of production under development for 2012. We are a unique player in a number of ways that might add interesting insights for today's discussion. We do not fit neatly in either the biofuels or the refinery camps.

We make isobutanol, which is a four-carbon alcohol. We make it in ethanol plants that we retrofit with our technology. Isobutanol

can be easily converted using existing refining and petrochemical processes into gasoline, diesel, jet fuel, and chemicals like synthetic rubber. In short, Gevo combines advanced biotechnology and traditional chemistry to make a platform hydrocarbon molecule.

So what kind of company are we after all? Well, we think we are something new, a harbinger of an energy future where barriers and boundaries between the agricultural and petroleum supply chains disappear. Welcome to the world of drop-in biofuels. Made from biomass but formed into end products using chemistry, drop-in biofuels require no flex fuel vehicles, special-blended pumps, or new pipelines.

Gevo has been able to work across the industry frontiers here in Washington. For example, I am Vice Chairman of the Advanced Biofuel Association and sit on the Boards of Bio and Renewable Fuel Association. We are also associate members of NPRA and SIGMA, and since we use starch from corn as one of our carbon sources, we are also actively involved with the Corn Growers Association. We get to see all sides of the energy debate.

I want to state up front that Gevo supports the RFS2 and stands ready to partner with Congress, the EPA, and our other stakeholders to assure its success. RFS2 is the most significant federal policy to spur the advanced biofuel industry. The program has helped create many opportunities for our company and our peer group companies, including the five that have recently become publicly traded.

We are all growing, adding jobs, and contributing to reduced fossil fuel use and petroleum imports. We salute the EPA for their efforts to implement the important program.

There are some aspects of policy and regulation that do present challenges to the adoption of advanced biofuels. This is understandable because these policies were established when ethanol was the only available biofuel, a time before the era of cost-competitive drop-in biofuels became possible.

Technology has evolved over these last 10 years, and a new advanced biorefinery industry has developed. We need to look at our policy and regulatory framework with fresh eyes in order to realize its promise.

I would like to just highlight one issue today to illustrate a challenge directly related to these conflicts and unintended consequences, subject of today's hearing. That is the issue of co-mingling, blending E10 gasoline with biobutanol or other advanced biofuels at retail gasoline stations. When the Clean Air Act was written, ethanol was the only available biofuel. So the act granted gasoline containing between nine and 10 percent a waiver to exceed evaporative emission guidelines by one pound of pressure, known as Reid Vapor Pressure or RVP.

This is a problem actually for Gevo and other biofuel producers. If you blend E10 gasoline with butanol, which has a very low RVP by the way the ethanol content is diluted below 10 percent, and thus, the fuel blended with biobutanol would, therefore, lose that one pound waiver, even though the fuel dispense would actually and could probably have a lower RVP than E10.

Per the Clean Air compliance point of view, this doesn't make much sense. We should be able to find a way to allow the commin-

gling of E10 and biobutanol so that the new biofuel could enter the market to lower evaporative emissions and contribute to cleaner air. We believe the EPA has the flexibility to address this issue, and we are currently in a very positive dialogue with them to resolve it.

Writing federal statutes and regulations with only ethanol in mind made sense in the past because there were no other available biofuel additives for gasoline, but that will be less and less true as time goes on. Many advanced biofuel manufacturers, including Gevo, are seeking to enter the Nation's gasoline supply, and we all need a policy and a regulatory environment that is open to innovation and new technology and lets the market reward those advanced biofuels based on their energy content, their emissions profile, and their compatibility with all engines and existing infrastructure.

So, in summary, we believe biofuels policy and regulation should create a level playing field for all biofuels and that the market should be empowered to choose those that have the best performance and price characteristics.

Thanks again for inviting me, and I look forward to answering your questions.

[The prepared statement of Mr. Huttner follows:]

PREPARED STATEMENT OF MR. JACK HUTTNER, EXECUTIVE VICE PRESIDENT, COMMERCIAL AND PUBLIC AFFAIRS, GEVO, INC.

Good afternoon, Mr. Chairman, Ranking Minority Member Miller, and Members of the Subcommittee. I am Jack Huttner, the Executive Vice President for Commercial and Public Affairs for Gevo, Inc. Gevo appreciates the invitation to testify at this hearing today on the "Conflicts and Unintended Consequences of Motor Fuel Standards."

Gevo is a Colorado-based renewable chemicals and advanced biofuels company. We are developing biobased alternatives to petroleum-based products. We are a unique biofuels player in a number of ways—ways that might add some interesting insights into this discussion. First of all, we make isobutanol, a four-carbon alcohol, via fermentation, but it can be also be made from petroleum. Does that make us a biofuel company? Biobutanol can be easily converted using known refining and petrochemical process into gasoline, diesel, jet fuel, and chemicals like synthetic rubber. We are also building a processing unit in Texas to make hydrocarbons. Does that make us a refinery company? Besides combining advanced biotechnology and traditional chemistry, to confound matters further, we also retrofit current ethanol plants to make isobutanol.

So, what are we in the end? Are we a biofuel company, a chemical company, a jet fuel producer, or what? Actually, we think we are something new, a harbinger of a new energy future where barriers and boundaries between the agriculture and petroleum supply chains disappear. Welcome to the world of drop-in biofuels, made from biomass but formed into end products using chemistry. Drop-in biofuels like biobutanol work well in small engines, marine engines, and automobile engines. It requires no flex fuel vehicles or special blender pumps. It can be transported through existing petroleum pipelines so no new transportation or fueling infrastructure is needed.

There are advantages to early innovators like Gevo and some disadvantages. Let's start with the advantages. First of all, we get to work across the frontiers with all sectors and this is particularly true here in Washington. For example, I am vice chairman of the Advanced Biofuels Association and sit on the boards of the Biotechnology Industry Organization and the Renewable Fuels Association. But, we are also active associate members of the National Petrochemical and Refiners Association and the Society of Independent Gasoline Marketers of America. And, since we use the starch from corn as one of our carbon sources, we also are actively engaged with the National Corn Growers Association. We get to see all sides of energy policy. It is an exciting and challenging place to be.

But, there are some disadvantages to go along with this "neither fish nor fowl" position. Chief among them is developing our various business segments in a policy and regulatory environment that was crafted before the era of cost-competitive drop-in biofuels became possible as they are becoming today. When ethanol was the only commercially viable biofuel, it was only natural that biofuel policy assumed that would always be the case. But technology has evolved over the last decade and a new industry has developed—advanced biorefineries.

Gevo is retrofitting its first ethanol plant to make biobutanol in Luverne, Minnesota. It is scheduled to come online in the first half of 2012 and is expected to have the capacity to produce 18 million gallons per year of biobutanol. About six months later, our second ethanol plant conversion, in Redfield, South Dakota, is scheduled to be completed, adding an expected additional 38 million gallons per year of biobutanol production capacity. By 2015, we plan to have approximately 350 million gallons of biobutanol production capacity from about nine plants across the nation.

We also recently announced a contract to supply the U.S. Air Force with blends of kerosene made from isobutanol and participation in a new project to develop cellulosic biojet technology.

Gevo is exactly the type of company, and biobutanol is exactly the type of advanced renewable fuel, that Congress was trying to encourage when it enacted the revised Renewable Fuel Standard (RFS) as part of the 2007 energy bill. In 2006, Gevo did not exist as a company. This year, we have over 110 employees in three states. We are hiring now and expect to continue expanding by 25% or more for the next several years.

Gevo supports the 2007 revisions to the RFS and stands ready to partner with Congress and interested stakeholders in assuring its successful implementation. The RFS2 program represents the most significant federal level policy to encourage the development of an advanced biofuels industry in the United States. We salute the EPA for their efforts in support of this program. The 2007 RFS2 program helped to create many opportunities for our company and we will continue to work hard to take advantage of those opportunities.

Gevo continues to face challenges as well, including some that relate directly to the "conflicts" and "unintended consequences" that are the subject of today's hearing. Each of these challenges can be resolved in a positive manner without direct congressional action, as long as we can all work collaboratively on the congressional goals for the RFS2 program. To that end, we are currently working in a constructive and positive manner with EPA to create a smooth regulatory framework for the deployment of drop-in biofuels.

One such challenge is the issue of commingling—blending E10 with biobutanol or other second-generation biofuels at retail gasoline stations. This challenge relates to the issue I mentioned earlier, namely, when the Clean Air Act was written, ethanol was the only biofuel available. So, the Clean Air Act granted gasoline containing between nine and 10 percent ethanol a waiver to exceed the evaporative emission guideline by one pound of pressure, known as Reid Vapor Pressure or RVP. This is a problem for Gevo and producers of some other biofuel components. If you blend a gasoline containing butanol with E10, the ethanol content is diluted below 10% in the underground storage tank and therefore loses the one-pound waiver, even though the fuel dispensed would likely have a lower RVP than E10. From a clean air compliance point of view, we should be able to find a way to allow the commingling of E10 and butanol so that a new, lower RVP biofuel can enter the market, lower evaporative emissions and contribute to cleaner air. We are currently in the early stages of discussion with the EPA and hope to resolve this issue.

A second challenge faced by Gevo and other advanced biofuel manufacturers is connected with EPA's proposal for new motor vehicle tailpipe emissions standards, expected early next year. These so-called "Tier 3" standards may include, among many other provisions, a change in the test gasoline used by EPA and motor vehicle manufacturers to certify that engines meet emissions standards. Since the 1960s, EPA has mandated that this "certification fuel" be pure gasoline without biofuel additives—in other words, E0. There is the possibility that the new Tier 3 rules will stipulate E15 as the new certification fuel.

In a vacuum, this change from E0 to E15 may seem innocuous. After all, E10 currently is prevalent across the Nation, and EPA recently approved the use of E15 in certain motor vehicles. However, this proposal raises significant concerns to Gevo and other biofuels manufacturers. If adopted, all engine manufacturers will "tune" their engines to that fuel so they can meet emission standards. This will likely further establish ethanol as the presumptive biofuel additive.

Writing federal statutes and regulations with only ethanol in mind made sense in the past, because there were no other viable biofuel additives for gasoline. But

that will be less and less true as time goes on. Many advanced biofuel manufacturers, including Gevo, are seeking to enter into the Nation's gasoline supply in the coming months and years, and we need a policy and regulatory environment that is open to new technologies and lets the market reward advanced biofuels based on their inherent energy content, emissions, and engine compatibility characteristics.

Congress did an admirable job in 2007 of drafting a revised RFS program that is technology neutral. A central focus of the RFS2 program was technology neutrality—allowing competing biofuel pathways to compete for market entry in a manner that is not biased by federal regulations. Congress drafted the RFS2 program in 2007 to avoid picking "winners and losers" among different biofuels technologies. EPA should do the same and fashion rules that embody the same intent and outcome to the greatest extent possible. We look forward to working with the EPA and Congress to assure that the implementation of regulations creates a level playing field for all advanced biofuels.

Thank you again for inviting me to appear at this hearing today. I would be pleased to answer any questions you may have.

Chairman HARRIS. Thank you very much. I thank the panel for their testimony. Reminding Members the Committee rules limit questioning to five minutes.

The Chair at this point will open the round of questions, and I recognize myself for the first five minutes.

Ms. Oge, looking through your testimony, you claim a pretty amazing amount of hospital visits prevented and millions of cases of respiratory problems including bronchitis and asthma. I have asked a previous witness from EPA to actually show me some of that data, and they were not forthcoming. So I am going to just tell you right upfront I am going to request that information from you as well, and I hope you are more forthcoming than others from the EPA.

Now, Ms. Oge, if the RFS did not exist, would, in fact, EPA be pursuing stricter limits on sulfur contents and fuel volatility as part of its Tier 3 rulemaking?

Ms. OGE. Absolutely. Let me go back and remind us what—when did we start thinking about Tier 3 until the previous Administration in 2008, a new standard was set to .075 parts per million. As part of the Regulatory Impact Analysis that the agency did at that time in 2008, we consider what we are calling today the Tier 3 Program. It is very typical for EPA when we establish public health standards to evaluate cost-effective ways that we can enter at the national level. So we get in a way that will reduce costs for localities and States so we don't have to force controls at the local and State level that can be very expensive.

So what we are calling Tier 3 today, which is a systems approach of reducing sulfur from gasoline because sulfur poisons catalysts and prevents catalysts from doing their job, and at the same time reduce emissions from cars. So the Tier 3 effort started the thinking back in 2008.

Now, in the meantime, we have been working with the State of California as they are moving forward to address car standards and, as you probably know, California has a low sulfur fuel, so they do have a 10-parts-per-million cap of sulfur so they are able to move forward with the standards. In order to have a 50-state program across the country and help areas that cannot meet today's existing ozone standard, which is about 55 areas across the country, we need to have clean sulfur to enable both the new technologies, but at the same time by lowering the sulfur level from 30 parts per million to lower, you can get significant reductions of ni-

trogen oxides and improve air quality across the board from the existing fleet.

Chairman HARRIS. Okay. Can the EPA demonstrate that the ozone National Ambient Air Quality Standards can't be met without the fuel property reductions required by Tier 3?

Ms. OGE. In 2008, the Agency looked at a number of strategies including Tier 3. We believe Tier 3 will be one of the most cost-effective ways that the Agency can undertake in order to reduce potential access at the State and local level, going to small facilities where the costs on reducing nitrogen oxide could be significantly higher.

As part of our proposal we are going to lay out the cost effectiveness of the actions that we are going to take, both for cost and reducing sulfur in gasoline.

Chairman HARRIS. Okay. Mr. Greco, Mr. Hilbert showed some pretty interesting pictures of the marine engines from the use of E15, pretty worrisome, actually. In your view does the final misfueling label for E15—is that going to solve the problem in not getting that fuel into those engines?

Mr. GRECO. We would say it is insufficient to do that. We submitted comments to EPA during the development of that label and feel that they were not accepted, and EPA, in fact, went with a label that we feel is less sufficient for that. So we have our concerns with the current label as finalized.

Chairman HARRIS. Well, let me follow up a little bit on a similar topic. In October, Ms. Oge is quoted as saying the EPA has, "held very productive discussions with both car companies and fuel providers," about the upcoming Tier 3 standards.

Now, do you agree with her characterizations of EPA's outreach to your——

Mr. GRECO. I am hearing a different story from my members who have met with Ms. Oge. We feel that—in our discussions there has been unanimity about the concerns that we have raised today in our testimony about the costs, the impacts on jobs, and energy security from this. And there is a united view of that amongst the refining industry.

Chairman HARRIS. Ms. Oge, that doesn't leave much doubt about where the industry stands, and they are the fuel providers. What do you define as a very productive discussion? I am not sure.

Ms. OGE. That is a good question.

Chairman HARRIS. If the fuel providers come in and say unanimously, look, this isn't practical, this won't work, what was the product of that? Because you used a very specific word, very productive discussion.

Ms. OGE. Well, first of all, I believe that the discussions were very productive and——

Chairman HARRIS. And that is my question: define productive.

Ms. OGE [continuing]. Let me define productive. Starting last February, I took my team, and I went to all the refineries, most of the refineries. We went to Texas, to Kansas, California. So to me the fact that EPA spends hours listening to the regular community, you know, we didn't invite them to come to us. We went and visited with them.

So I feel that what we heard from the industry was very productive, because that is how we are going to design the program. I think the program that we are designing and we haven't proposed anything. The Administrator has not proposed any standards, we haven't sent the proposal to OMB, so I think for the industry to say that our discussions were not productive, it is unfortunate, because they don't know how those discussions are forming the policy that the agency is going to recommend.

So I would strongly suggest in my mind productive doesn't mean we agree on everything. Productive is that the EPA is listening carefully, and the industry was offering very important information, and we need it on a one-on-one basis with each of the refineries rather than meeting with the association where they could not disclose confidential information.

So we have confidential information, I think, that discusses we are very productive, and when the proposal is going to go out, I think the industry is going to realize that, indeed, those discussions that we had with individual refiners have ended in a program that is going to be very flexible and cost effective.

Chairman HARRIS. Okay. I guess people can disagree.

Mr. Miller.

Mr. MILLER. Mr. Chairman, before I begin my testimony, I would like to move into the record. Mr. Costello could not be here, but he wanted to introduce into the record a letter from Virginia Dale, Dr. Virginia Dale, the director of the Center for Bioenergy Sustainability at Oak Ridge National Laboratory. The letter provides some helpful comments on the NRC report.

Chairman HARRIS. Sure. I would note that the representative of Oak Ridge National Laboratory has informed us the letter from Dr. Virginia Dale, despite appearing on Oak Ridge National Laboratory letterhead, reflects her views as a member of the National Academy's biofuels panel and does not represent the views of the lab on the issue. Well, you laugh, but that is an important point, because you know when you write on Congressional letterhead, it has to be—you are representing the U.S. Congress, and you know, we have strict rules. But with that entered in the record here, I have no objection to the letter, just with that statement from Oak Ridge.

[The information may be found in Appendix 2.]

Mr. MILLER. Thank you. Beginning my five minutes, Mr. Huttner's testimony was far more conciliatory towards the EPA than some of the majority witnesses in this Committee. I don't think he actually used the term very productive, but he seemed to suggest in his testimony that you were having useful conversations and that you were willing to talk to them.

And both Mr. Huttner and Dr. Kesan mentioned a specific regulatory difficulty of blending E10 with biobutanol or other advanced fuels, and I do understand that there are some regulatory obstacles to the introduction of biobutanol to the marketplace.

First, do you agree that biobutanol is a promising drop-in fuel, and assuming that those new fuels are able to meet all Clean Air Act standards, could the obstacle that Dr. Kesan and Mr. Huttner referred to be overcome through your procedures? Are you aware of the specific blending issue?

Ms. OGE. Thank you, Mr. Miller. First of all, let me say that isobutanol or biobutanol is probably one of the most promising fuels because what it is it is a drop-in fuel, so actually you—it becomes part of the refining product so you don't have to blend it at the retail stations, so there are a lot of issues with infrastructure and so forth that isobutanol doesn't have. So, indeed, it is a very promising fuel.

We are having productive discussions with a company, another company——

Mr. MILLER. Very productive or just productive?

Ms. OGE. Very—I want to underline very productive.

Mr. MILLER. All right.

Ms. OGE. And I think this is—you have raised very important issues because clearly when the Clean Air Act was drafted, there were different issues that Congress was intending at the time. So we are working very closely with the companies so that we are capable of finding pathways to allow this promising fuel in the marketplace.

Mr. MILLER. Okay. Dr. Kesan, I think that Mr. Huttner used the term flexibility. Since you are on the university faculty, I think you used the term regulatory innovation, but it seems to be the same concept, and that had happened in the past to meet Clean Air requirements to allow new fuels on the marketplace.

How has that flexibility or regulatory innovation helped meet renewable fuel standards and other standards required by the Clean Air Act?

Dr. KESAN. I agree with Ms. Oge and with Mr. Huttner that this is a really good opportunity, and isobutanol has some significant potentials. What I suggest in the written article that you are referring to is that if you are concerned about a particular oxygenate percentage by weight as being something that you have approved in the past, if that is the underlying scientific concern that you have sort of capped it at a particular percentage, 2.7, 3.7, whatever it is, to the extent that you can actually blend an equivalent of butanol that results in the same oxygenate percentage by weight, for example, then clarifying that and clarifying precisely what kind of blending percentages you can have would help a lot. It would help a lot because there is—that is an area of uncertainty, and there have been, as I outlined in the article you mentioned, there are sort of ways that you can do this, and the EPA has done that with various sort of substantially similar rulemaking in the context of methanol and other places.

And so I do think that there is an opportunity to capture the benefits offered by a fuel that might satisfy the advanced biofuel threshold of, you know, 50 percent GHG reductions and which is an important objective in RFS2, at the same time meet all the concerns, you know, environmental and otherwise.

Mr. MILLER. Mr. Huttner, this was your issue. Do you have anything to say about the flexibility or the regulatory innovation of EPA in addressing this regulatory obstacle?

Mr. HUTTNER. No. Thank you, and I appreciate the remarks of the other witnesses, and I would say that for a new and emerging company like Gevo bringing innovation and new jobs to the economy, representing the advanced biofuel sector, which is a new sec-

tor trying to work its way with the petroleum and the existing ethanol industry, engaging with the regulatory and policymakers early on in our activity is an important kind of value that we have as a company. Only in that way can we really assure that we can find our way into the market with all the big guys.

So as a newcomer one of those things that we do is try to go out early and meet with people.

Mr. MILLER. My time has expired.

Chairman HARRIS. Thank you. The Chair now recognizes the gentleman from California, Mr. McNerney.

Mr. MCNERNEY. Thank you, Mr. Chairman. I wasn't sure whether you were going to call myself or my colleague from California first.

So, Mr. Williams, in your testimony you provided some achievements of the members of the NPRA in their commitment to clean air and clean water. Very commendable. You mentioned all have been outstanding, have an outstanding record of complying with the EPA, have provided hundreds of billions of dollars of investment to dramatically reduce the levels of sulfur in gasoline to 90 percent and diesel to 90 percent, too.

These are excellent achievements. Let me ask you a simple—two simple yes, no questions. Would your members have done this without federal regulation and enforcement?

Mr. WILLIAMS. Some of the reductions, yes, I believe—we are not saying we are opposed to all regulations. The point of my testimony is that we are getting to a point where, you know, we would consider it to be almost a tipping point. You have lots of overlapping and conflicting regulations that are creating significant challenges for our industry, and that is one of the things I said in my written testimony and my opening statement was that, you know, we support sensible regulations. It is just a matter of measure, and it is a matter of whether or not these things actually can work together.

Mr. MCNERNEY. How many jobs were lost in that process?

Mr. WILLIAMS. Well, they did have some costs. If you look at the chart in the back of my testimony, it isn't my chart, it is the Department of Energy. There were 66 refinery closures in the last 20 years because of some of those regulations, and those regulations obviously weren't the only factor. There were a lot of factors, but they were a significant factor according to DOE. I don't have specific job numbers on that, but again, the DOE chart——

Mr. MCNERNEY. So those refineries were closed before 2004?

Mr. WILLIAMS. Those refineries, some of them closed after 2004, and again, the chart lists just since 2008, there have been about three refinery closures. There was an announcement recently that two companies unfortunately feel they are going to have to close three more refineries if they can't find a buyer over the next year.

Mr. MCNERNEY. Well, at that point in your testimony, you changed and stated that you see no evidence that further reductions would improve future vehicle technology, but I would like to submit for the record, Mr. Chairman, two records, one from the Association of Global Auto Manufacturers and the other from the Alliance of Automobile Manufacturers who disagree with that in that the amount of sulfur still is damaging to their catalytic converters.

Chairman HARRIS. Without objection.

[The information may be found in Appendix 2.]

Mr. WILLIAMS. Would you like me to comment on the——

Mr. MCNERNEY. Sure.

Mr. WILLIAMS [continuing]. Auto Alliance letter? We have obviously seen that letter, too, and we haven't seen any evidence that current sulfur levels are actually deteriorating catalysts. There are obviously a lot of cars out on the road right now running on existing levels of sulfur in gasoline.

Not only that but there are at least 19 vehicle models that can meet Tier 3 vehicle standards and run off Tier 2 sulfur gasoline, and they are not expensive models. They are things like the Chevy Malibu and the Ford Focus. So it——

Mr. MCNERNEY. Well, I am glad it is your opinion, but the two letters from the Automobile Manufacturers and the testimony of Ms. Oge contradict that. So I don't think it is a clear case there is no improvement still, and I think that is an area that we need to be diligent to move forward in.

Let me ask what is it that is keeping the Association back from wanting to do additional refining. Is it the cost? Is it the jobs?

Mr. WILLIAMS. Additional refining or additional regulatory measures?

Mr. MCNERNEY. Well, refining additional sulfur out of gasoline?

Mr. WILLIAMS. Yeah. I mean, I think, you know, my colleague over at API highlighted some of the costs associated with those reductions and the Tier 2 reductions started in 2007, but weren't finalized until—or started in 2000, I am sorry, and weren't finalized until 2004, and 2007. EPA recognized those would be onerous, which is why you had the lead time.

Mr. MCNERNEY. Well, Mr. Greco indicated a 12 to 25 cent per gallon cost, but the National Association of Clean Air agencies state that the cost would be less than one cent. So, again, I don't see any verification for these statements that improvement is not going to hurt the economy and that the cost is going to be that drastic.

Mr. GRECO. We would be happy to go over our study with you at your convenience. We just got the NACA study like you did, so we did not have the benefit of looking at it. We did model 112 refineries nationwide. So we stand by our study and feel it is very robust and credible.

Mr. MCNERNEY. Well, I think the statement of Dr. Kesan that uncertainty is the problem in terms of cost production. So putting regulations in place that allow refineries and producers to plan ahead for 10 years and meet these levels is going to be much more cost effective than waffling back and forth on these issues, especially when the health and safety of our children is involved.

Thank you, Mr. Chairman.

Chairman HARRIS. Thank you. The Chair now recognizes the gentlelady from California, Ms. Woolsey.

Ms. WOOLSEY. Thank you very much.

First of all, Mr. Williams, I am just going to not repeat what my colleague just asked you. Tell me what did the NPRA sit here and say when they were deciding on the first tier of regulations? Were you for it, did you know it was going to be okay, what did you say?

Mr. WILLIAMS. Which—are you talking about Tier 2 specifically?

Ms. WOOLSEY. Tier 2.

Mr. WILLIAMS. Tier 2. Yeah. Our association industry supported reductions in sulfur in gasoline. We did have some concerns about the extend of the reductions and some of the time frames.

Ms. WOOLSEY. Uh-huh.

Mr. WILLIAMS. And I can get you more details on that——

Ms. WOOLSEY. Okay. Well, I just——

Mr. WILLIAMS [continuing]. Prior to my time——

Ms. WOOLSEY [continuing]. Want to be clear.

Mr. WILLIAMS. But we did support some cuts in sulfur.

Ms. WOOLSEY. Yeah. Right. Experience doesn't always support being against change because then we learn, oh, my, that was a success.

Mr. Greco, on the 25 cents a gallon increase, what industry in this country has higher profits than yours? Why would that 25 cents that it is going to cost to clean our air fall on the shoulders of the consumer?

Mr. GRECO. Well, first that 25 cents is a manufacturing cost. I cannot say how much of that cost would get passed onto the consumer.

Regarding your other statement, if you look at the earnings statements of the various member—various companies, our profits on a per dollar sales basis are actually in line if not a little lower than many companies; many high-tech companies based in California, for example, have significantly higher profits than oil companies.

That being said, we have invested as my testimony mentions, over $100 billion in the past 20 years on environmental improvements on making cleaner fuels, and we have seen the benefits of that. As Mr. Williams said, our air is significantly cleaner than it was 20 years ago. Now, that is a combination of cleaner vehicles enabled by cleaner fuels. We are just saying that at this point we are seeing diminishing returns from those changes.

Ms. WOOLSEY. Okay. Well, thank you very much on that. It is my understanding that ethanol makes up 10 percent of the U.S. daily gasoline demand, about 10 percent. If ethanol were not part of our fuel system, how would that 10 percent of the fuel supply be filled, and do you think it would cost consumers more or less if we don't have ethanol?

I will start with you, Mr. Greco, and Mr. Williams, I would like you to answer that and then I am hoping Ms. Oge will answer it also.

Mr. GRECO. I mean, I can't predict the cost in that case. We find——

Ms. WOOLSEY. What would it be if it wasn't ethanol?

Mr. GRECO. It would be other components of the hydrocarbon. It would be lighter-ends gasoline. It depends on each refinery. Each refinery had to make those investment decisions and blending decisions based on their unique operation. So there is not a single answer that I can give you.

Ms. WOOLSEY. Okay. Mr. Williams, do you have an idea of what would fill that need?

Mr. WILLIAMS. So just for clarity, you are asking what the cost would be if there was more ethanol in——

Ms. WOOLSEY. No, if there was less. If we took away the ethanol.

Mr. WILLIAMS. So if you had less ethanol——

Ms. WOOLSEY. Less ethanol. No ethanol.

Mr. WILLIAMS [continuing]. What would the cost be, and you know, I would echo Mr. Greco's comments that we cannot predict price; however, we can say that ethanol has lower energy content than a gallon of gasoline, so there would be an efficiency boost. EPA has already said in a public letter that there is a mild, a fuel economy penalty, fuel efficiency penalty.

Ms. WOOLSEY. Well, let us have Ms. Oge, if you would like to respond to that.

Ms. OGE. We would not have 10 percent ethanol. I think you would have some ethanol because ethanol improves the octane of gasoline, so it is a very important property in gasoline, so you would have some ethanol, and then you would have other aromatics, other compounds that are gasoline-based, compounds that currently have ethanol. For example, ethanol reduces the amount of benzene and aromatics.

So, again, that is somewhat less toxic substances in the gasoline make-up.

May I speak a little bit about the price issue?

Ms. WOOLSEY. Yes.

Ms. OGE. So, you know, the API study basically makes certain assumptions of what EPA is going to do. EPA has not declared what we are going to do as part of Tier 3. Actually, our Tier 3 efforts are concentrating on reducing sulfur less than 30 parts per million.

So the NACA report is more close, the stated report of what EPA is planning to do. API study made a lot of assumptions of actions that EPA is going to take as part of Tier 3, but that is not accurate.

Ms. WOOLSEY. Thank you.

Mr. GRECO. Can I respond to that?

Ms. WOOLSEY. My time is up. I would be glad to have them respond. Mr. Chairman, it is up to you.

Chairman HARRIS. Sure, Mr. Greco.

Mr. GRECO. Thank you. We made the best assumptions we could at the time. It has been a shifting field with EPA as to what this target would be. We expect about a 60-day comment period. That is probably not sufficient time for us to do a full-blown study when we get the proposal, which is why we are asking for the study now to see the data and then go to a rulemaking.

Chairman HARRIS. Thank you. I now recognize the gentleman from New York, Mr. Tonko.

Mr. TONKO. Thank you, Mr. Chair. Mr. Williams, in your written testimony you applaud your industry for its significant emissions reductions through compliance with Tier 2 standards, which were responsible for a 90 percent reduction in sulfur emissions.

You also claimed no further regulation of sulfur content is necessary. It is widely known that there is a harmful effect from sulfur emissions that is posed to public health. In fact, the National Association of Clean Air Agencies, the Northeast States for Coordinate Air Use Management, and the Ozone Transport Commission have all come forward in support of Tier through regulations, not-

ing the significant impact reduced sulfur emissions have on public health.

So, Mr. Chair, with your permission I would like to ask unanimous consent to submit for the record statements from these three organizations that I just mentioned.

Chairman HARRIS. Could we see them? I don't think they have been shared with the Majority staff.

Mr. TONKO. Certainly.

Chairman HARRIS. If you can just keep them——

Mr. TONKO. Okay.

Chairman HARRIS [continuing]. I will rule on that.

Mr. TONKO. Thank you. Thank you. The goal of the yet-to-be-proposed Tier 3 standards is to reduce hazardous pollutants in order to help States and local air quality agencies reach the 2008 National Ambient Air Quality Standards requirements. It seems to me that we have the technology to further reduce these toxic pollutants and achieve our current goals which will help reduce respiratory infections and other respiratory illnesses.

So, Mr. Williams, in your testimony you state that there is a minimum benefit to reducing the already minimal amount of sulfur emissions from cars. Why do you claim there will be minimal benefit to reducing sulfur?

Mr. WILLIAMS. Well, we are already going to continue getting reductions based on the Tier 2 standards that, again, were implemented in 2004 and 2007. In fact, you mentioned the 2008 ozone NAAQS. The RIA itself doesn't explicitly say that Tier 3 for fuels is needed. It does talk about some catalyst technology improvements that could be a potential; however, I believe there are about eight new counties that are going to be out of attainment with the 2008 ozone NAAQS standard, and those counties are actually going to come into attainment with the Tier 2 standards before Tier 3 would even be implemented from what we preliminarily heard from EPA.

And, again, there are—you wanted to discuss the vehicles earlier. There are Tier 3-capable vehicles that can run on Tier 2.

So you continue to see sulfur reductions. It is just a matter of we have gone from 300 down to 30 PPM and now we are looking to go down to 10, and we didn't go to 30 too long ago. Getting back to one of the other points of my testimony, how do all these things really interact with, you know, EPA in another letter mentioned that the Renewable Fuels Standard could actually see some potential emissions increases, and one of the reasons for the anti-backsliding study and the Energy Independence and Security Act was to assess that, and it was pretty clear that Congress said you do the 2008 anti-backsliding study and then get an assessment of what is going to happen to the fuel supply and then what measures might be necessary to do any additional work.

Now we are being told that the anti-backsliding study is going to come out at the same time as the Tier 3 regulations. So the reaction is happening before there is anything to really react to and we have a full understanding of the consequences.

Mr. TONKO. Ms. Oge, do you have any comments on this regard?

Ms. OGE. Thank you. We—scientifically it is proven that sulfur poisons catalysts. It is like back in the '70s when we had to remove lead to enable the three-way catalyst.

So it is not a secret that the higher the sulfur level, the more it impacts the effectiveness of a catalyst. California has 10 parts per million sulfur, Europe, Japan, other countries. We have the most advanced automotive technologies. We need a better quality for our fuel to enable the catalyst to perform to the best potential for those precious metals.

On the other hand, there is extensive data to show that today's cars will benefit by having low sulfur, by reducing nitrogen oxides. As a result, cleaner air for 130 million people that breathe in healthy air in this country.

Mr. TONKO. Thank you. When it comes to reducing NAAQS, what source, in your opinion, Ms. Oge, is the most cost effective?

Ms. OGE. We believe that efforts that we are undertaking, the Tier 3 efforts, which is to reduce NAAQS, emissions, and hydrocarbons from tailpipe emissions and from cars, combining it with low sulfur level, would provide some of the cost-effective strategies for local and State governments to address ozone air pollution.

Mr. TONKO. Thank you. I yield back to Mr. Chair.

Chairman HARRIS. Thank you very much. I would also like to take this opportunity to ask you—and by the way, we will enter those—there is no objection, so we will enter them.

[The information may be found in Appendix 2.]

Chairman HARRIS. I would like to take this opportunity to ask unanimous consent to add a few items into the record as well. These items are in the public domain and have been shared with the minority. The executive summary of the National Research Council's report, Renewable Fuel Standard Potential Economic and Environmental Affects on U.S. Biofuel policy, the National Renewable Energy Laboratory and Mercury Marine report, high ethanol fuel endurance, the study of the effects of running gasoline with 15 percent ethanol concentration and current production outboard four-stroke engines and conventional two-stroke outboard engines, the executive summary of the Baker and O'Brien study, potential supply and cost impacts of lower sulfur, lower RVP gasoline, responses requested by Vice Chairman Sensenbrenner on warranty and liability concerns about E15 which were sent by BMW Chrysler Ford GM, Honda, Hyundai, Kia, Mazda, Mercedes, Nissan, Subaru, Toyota, Volkswagon, Volvo, Briggs and Stratton and Mercury Marine, statements objecting to EPA's granting of a partial waiver for E15 from the Alliance of Automobile Manufacturers and the Association of Global Auto makers, and a letter send by the Chairman of the Full Committee to Administrator Jackson about Tier 3 and EPA's responses.

Without objection, so ordered.

[The information may be found in Appendix 2.]

Chairman HARRIS. I thank the witnesses for their valuable testimony and the Members for their questions. We are going to get out on time despite a late start.

The Members of the Subcommittee may have additional questions for the witnesses, and we ask, and we will ask you to respond to those in writing. Ms. Oge, I am going to have to ask you specifi-

cally; the EPA is particularly unforthcoming with answers. Other EPA witnesses. So I hope you break the mold on that. I will ask you to respond to the questions in writing. The record will remain open for two weeks for additional comments from Members.

The witnesses are excused, and this hearing is adjourned.

[Whereupon, at 3:57 p.m., the Subcommittee was adjourned.]

Appendix

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Mr. Brendan Williams, Senior Director of Advocacy, National Petrochemical and Refiners' Association

Questions Submitted by Chairman Andy Harris

Q1. In your testimony, you state that NPRA believes that a comprehensive cost-benefit analysis would be in the national interest. This Congress passed the TRAIN Act to require such an analysis on the stationary source regulation. Do you envision similar legislation for mobile source regulation? Or should the cost-benefit of the stationary regulation include existing and potential regulation on mobile sources as well?

A1. Comprehensive cost-benefit analysis on both stationary and mobile source regulations is in the best interest of the Nation. We understand that federal and State regulators have a hard time balancing the need for effective regulation and economic development. However, the size, scope, and cumulative burden of current and impending regulatory activity is creating uncertainty and conflicts that burden the domestic fuel supply. Legislation like the TRAIN Act is a significant step forward to ensure the regulatory blizzard that fuel producers are facing does not put them out of business.

Many mobile source regulations facing fuel producers need to be examined because of their tremendous cost, conflicts with other regulations, and their potential to negatively impact the economy. Considering both mobile and stationary sources together in cost benefit analysis is critical, because mobile source regulations can create conflicts with stationary source regulations. As discussed in my testimony, such is the case with EPA's Tier 3 gasoline regulations, which would require new energy-intensive processes that could lead to more greenhouse gas (GHG) emissions and come in conflict with EPA's GHG regulations under the Clean Air Act. In addition, EPA is moving forward with the Tier 3 rulemaking without conducting the anti-backsliding study required in section 209 of the Energy Independence and Security Act of 2007 (EISA 2007). Not only does this move contradict congressional intent, but it could lead to additional regulatory conflicts if the study indicates the RFS could complicate Tier 3 in some manner (or vice versa). In September, the House passed the Kinzinger-Gonzalez Amendment to the TRAIN Act 269–145. The amendment would ensure the economic and jobs impacts of EPA's Tier 3 regulations are thoroughly analyzed and reviewed. NPRA supported this important amendment.

Q2. How has the inclusion of mandated volumes of com ethanol impacted our reliance on foreign oil? What effect will cellulosic ethanol production have on fossil fuel use?

A2. The inclusion of mandated volumes of corn ethanol has not reduced U.S. reliance on foreign oil. While such a goal may have been the law's intent, the result has been negligible. Refineries still need crude oil to produce petroleum products that are not affected by corn ethanol, such as home heating oil, diesel, and jet fuel.

Ethanol was used in the fuel supply before the RFS2 mandate because it is a source of octane. Ethanol currently makes up slightly less than 10 percent of the domestic gasoline supply. It has lower energy content than gasoline, resulting in slightly lower fuel economy. It will be extremely difficult to blend more than 10 percent ethanol into the fuel supply given extensive issues that need to be addressed to overcome the "blendwall" (e.g., the fact that vehicles and infrastructure handling the existing fuel supply are not equipped to run on gasoline containing more than 10 percent ethanol).

It is premature to speculate on the effect of cellulosic biofuels. Large volumes of these fuels were mandated in EISA 2007. The law required the use of 100 million gallons of cellulosic biofuels in 2010 and 250 million gallons in 2011. Yet despite these mandates, no cellulosic biofuels have been produced to date.

Q3. In addition to the litany of mobile source regulations facing your industry, it is my understanding that President Obama has endorsed a low carbon fuel standard modeled after the one in California. What would be the impacts of a national low carbon fuel standard?

A3. A national LCFS would essentially create a cap-and-tradelike system for the fuel supply, which would likely result in significant increases in fuel costs and threaten the availability of supply around the U.S. A recent study by Charles River Associates (CRA) shows that a national LCFS would raise the cost of transportation fuels by up to 80 percent within five years and up to 170 percent within 10 years.

Along with the significant increase in transportation costs, the study shows a national LCFS policy could lead to closures of upwards of 50 U.S. refineries.

Furthermore, a national LCFS not only impacts the fuel supply, but the economy as a whole, significantly reducing consumer purchasing power and the fiscal health of the U.S. The CRA study indicates a national LCFS would result in an estimated 2.3 million to 4.5 million net American jobs lost by 2025 from baseline levels, with 1.5 million losses from the manufacturing sector alone. This study also indicates that the average American household's annual purchasing power would be reduced between $1,400 and $2,400 by 2025 relative to 2010 levels. In addition, studies conclude a national LCFS would lead to a decline in U.S. Gross Domestic Product of two to three percent—or $410 billion to $750 billion—by 2025.

Q4. When the U.S. went from leaded to unleaded gasoline, EPA mandated fuel nozzles for leaded gasoline differ from those for dispensing unleaded gasoline. Despite this difference, there was a 20 percent incidence of misfueling. Given this historical figure, what is your opinion of the chance of misfueling with E15 for on-road legacy vehicles—pre-2001—and off-road engines if the only safeguard is a misfueling label?

A4. NPRA cannot speculate on the likelihood of misfueling with the only safeguard being the misfueling label. However, NPRA has significant concerns about E15 being sold under the same canopy as regular gasoline, as this could result in a greater chance of misfueling. In June 2011, EPA introduced an orange and black label to make drivers aware of the change to prevent misfueling. We do not feel that the label is sufficient to prevent consumers from misfueling.

EPA's decisions in November of 2010 and January 2011 to grant a partial waiver for gasoline containing 15 percent ethanol, known as E15, to be sold in the marketplace for cars and light trucks produced in model year 2001 or newer are illegal. EPA does not have the authority to grant a partial waiver, and this product will most likely create significant problems in the marketplace, including enhancing the probability of misfueling.

Several studies show that misfueling with gasoline blends containing more than 10 percent ethanol can result in engine damage for not only cars and light trucks, but also non-road engines, such as lawnmowers and boats. For example, two recent studies by the National Renewable Energy Laboratory tested the effects of E15 on marine engines and found E15 resulted in problems with engine performance and durability, increased fuel consumption, and increased nitrogen oxide emissions. Furthermore, increased ethanol blends could damage cars' catalytic converters, which were installed to reduce emissions, and its corrosive nature could damages fuel tanks and fuel dispensing equipment, putting people at greater risk. Even the Government Accountability Office (GAO) released a report stating that E15 needs further studies due to the potential negative impacts it would have to consumers.

Questions Submitted by Ranking Member Brad Miller

Q1. Please provide your name and employment organization(s).

A1. Brendan Williams. National Pertochemical & Refiners Association.

Q2. Are you an officer or employee of, or otherwise compensated by, any other organizations(s) that may have an interest in the topic of this hearing?

A2. Yes.

Q3. If the answer to question 2 is "yes," please specify the organization(s) and the nature of your relationship with the organization(s).

A3. NPRA represents virtually every refinery and petrochemical facility in the U.S., as well as many companies who have a relationship with the refining and petrochemical industries, but do not actually possess refineries or petrochemical facilities. A full list of NPRA members can be found on our Web site: *www.npra.org*.

Q4. in the last three calendar years, including this one, have you been a registered lobbyist?

A4. Yes.

Q5. If the answer to question 3 is "yes," please list all of your client(s) that may have an interest in the subject matter of this hearing, and the dates between which you represented that client or those clients.

A5. For a list of all members of NPRA, please visit *www.npra.org*. I have been with NPRA since 2007.

Q6. if you have worked as an attorney, contractor, consultant, paid analyst, or in any other professional services capacity, please provide a list of all of your firm's clients who you know to have an interest in the subject matter of this hearing. These should be clients that you have personally worked with in the past three calendar years (including the present year). Provide the name of the client, the matter on which you worked, and the date range of that work. If there was a deliverable, please describe the product.

A6. N/A.

Q7. Please provide a list of all publications on which you have received an author or coauthor credit relevant to the subject of this hearing. If the list is extensive, the 10 most recent publications would be sufficient.

A7. N/A.

Responses by Dr. Ingrid Burke, Director of the Haub School and Ruckelshaus Institute of Environment and National Resources, University of Wyoming,
Co-Chair, National Research Council Committee on Economic and Environmental Impacts of Increasing Biofuels Production

Questions Submitted by Chairman Andy Harris

Q1. How has increased ethanol production had an effect on the number of acres dedicated to corn production in the U.S.? How has our soil, water, and wildlife habitat been affected as a result?

A1. Responses are based on the content of the report *NRC report Renewable Fuel Standard. Potential Economic and Environmental Effects of U.S. Biofuel Policy* with references to specific pages.

The percent of U.S. corn production used for fuel ethanol has been increasing since 2001 (Figure 2-3 on p. 37). USDA-ERS data indicate that planted acreage for corn has increased in this decade compared to the last one.

As corn acreage increases, greater nitrogen fertilizer is applied to achieve desired yields. Thus, there is a tendency for greater runoff and loadings to streams and rivers from increased corn production (p. 234), thereby decreasing water quality. In fact, a recent analysis of the National Water Quality Assessment programs found that since 1980 most of the drainages associated with the Mississippi River increased in flow-normalized concentration and flux of nitrate. Many studies relate the hypoxic area in July to August to the nitrogen loading emanating from the Mississippi River and Atchafalaya River from May to June, suggesting that increases in nitrogen runoff serve to increase gulf hypoxia (p. 232).

The effect of increasing corn production in the United States on soil and biodiversity is largely site specific and depends on the condition of the land before it was put into corn production. If the land was already in annual crop production, then the conversion to corn production might not have a large additional effect on soil and biodiversity. In contrast, if the expanded production involves removing perennial vegetation on a piece of land and replacing it with corn, then the land conversion results in losses of major stores of soil carbon and disrupts the future potential for storing carbon in soil (p. 252). The land conversion from perennial vegetation to corn has also been shown to be correlated with reduced grassland bird diversity and population. Likewise, taking land from the Conservation Reserve Program (CRP) out of retirement to grow corn for ethanol raises similar soil quality and biodiversity concerns (p. 254).

Q2. Will second generation bioenergy crops like switchgrass and Miscanthus use more or less water than current crops like corn and soybeans? Also, will they use more or less fertilizers and pesticides?

A2. Whether switchgrass and *Miscanthus* use more water than corn and soybean largely depends on where the crops are grown and whether they are irrigated (pp. 244 and 248). Studies have shown that switchgrass and *Miscanthus* yield increases with precipitation and irrigation (Heaton et al., 2004; Robins, 2010). Thus, if the crops are grown in dry areas and are irrigated to enhance yield, then switchgrass or *Miscanthus* would not necessarily use less water than corn.

The average nitrogen fertilization rate for corn is 138 lbs/acre (p. 207). The reported nitrogen fertilizer use ranges from 50 to 100 lbs/acre for *Miscanthus* and from 0 to 200 lbs/acre for switchgrass (p. 208). Although *Miscanthus* and switchgrass have the potential to use less nitrogen fertilizer than corn, it largely depends on the condition of the land on which the crops are grown and the management decisions that individual land operators make.

Severe pest and disease outbreaks have not been reported outside the tropics for switchgrass and *Miscanthus* (p. 109). They are likely to use less pesticides than corn and soybean. However, the pest and disease dynamics could change if cultivation of switchgrass and *Miscanthus* increases and become more intensive to achieve desired yields.

Q3. Why did the NRC panel find that the RFS "may be an ineffective policy for reducing global greenhousegas emissions"?

A3. Processes that affect GHG emissions of biofuels include land-use and land-cover changes, CO_2 storage in biomass during growth and emissions from fossil fuel combustion in the manufacturing, transport, and application of agricultural inputs, from fermentation to ethanol, and from tailpipe emissions (p. 5). Some of those processes that affect GHG emissions are highly variable, even within one given type of

biofuel. For example, GHG emissions are strongly influenced by whether a biorefinery uses fossil fuel or bioelectricity, or whether any direct or indirect land-use changes were incurred for feedstock production. The published estimates of life-cycle greenhouse gas emissions of corn-grain ethanol vary from 52–177 g CO_2 eq per MJ (p. 220). The range of values illustrates how changes or variations in processes (for example, fossil fuel vs. bioelectricity use, coproduct production, amount of fertilizer input, or extent of indirect land-use change) can result in different GHG emissions for the same fuel type.

If no direct or indirect land-use or land-cover changes are incurred, biofuels tend to have lower life-cycle GHG emissions than petroleum-based fuels. Feedstocks such as crop and forest residues and municipal solid wastes incur little or no direct and indirect land-use or land-cover changes; therefore, cellulosic biofuels made from those feedstocks are more likely to reduce GHG emissions when care is taken to maintain land productivity and soil carbon storage.

Other cellulosic feedstocks such as switchgrass and *Miscanthus* can contribute to carbon storage in soil, particularly if they are planted on land with low carbon content. For example, planting perennial bioenergy crops in place of annual crops could potentially enhance carbon storage in that site. However, planting switchgrass and *Miscanthus* on existing cropland can trigger indirect land-use changes elsewhere that can result in large GHG emissions. Although RFS2 can levy restrictions to discourage bioenergy feedstock producers from land-clearing or land-cover change in the United States that would result in net GHG emissions, the policy cannot prevent indirect land-use changes nor can it control such land-use changes outside the United States. Therefore, the extent to which RFS2 contributes to lowering global GHG emissions is uncertain.

Q4. Can you describe the consensus process used by the NRC panel in reaching their conclusions? Did any of the individual members disagree with the findings?

A4. Each member acts in an individual capacity and brings a unique expertise to the committee. Committee members are asked to consider respectfully the viewpoints of other members, to reflect their own views rather than be a representative of any organization, and to base their scientific findings and conclusions on the evidence. The committee deliberates in meetings to develop draft findings and conclusions.

Once the study committee has a consensus draft of its report, it is subject to an independent peer review overseen by Academy members on the Report Review Committee. The peer review process typically strengthens the reports significantly, as the Academy will not issue a report until it is satisfied that the questions given to the study committee have been adequately addressed (and that the study committee did not go beyond its task to address other questions), that the conclusions made in the report are well supported, and that all important issues raised in the review have been addressed.

Study committee members are asked to sign off on the final draft of the report. Each committee member has the right to issue a dissenting opinion to the report if he or she disagrees with the consensus of the other members.

Thus, NRC reports not only represent the consensus views of the authoring study committee, but also have the institutional endorsement of the National Academies (*http://www.nationalacademies.org/studyprocess/index.html*).

All committee members agreed to the content and signed off on the report *Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy*. No dissenting opinions to the report were registered

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Heaton, E., T. Voigt, and S.P. Long. 2004. A quantitative review comparing the yields of two candidate C4 perennial biomass crops in relation to nitrogen, temperature and water. *Biomass and Bioenergy* 27(1):21–30.

Robins, J.G. 2010. Cool-season grasses produce more total biomass across the growing season than do warm-season grasses when managed with an applied irrigation gradient. *Biomass and Bioenergy* 34(4):500–505.

Questions Submitted by Ranking Member Brad Miller

Q1. As I understand it, your study assumes no further technology advances for biofuels. Would you characterize this as a reasonable assumption given the current state of the biofuels industry? Why did the NRC choose to make this assumption?

A1. Response is based on the content of the NRC report *Renewable Fuel Standard. Potential Economic and Environmental Effects of U.S. Biofuel Policy* with reference to a specific page and appendix.

The NRC study does not assume "no further advances for biofuels." The committee performed a "sensitivity analysis" to account for technology advances for conversion of biomass to fuels (p. 109). Based on an exhaustive review of the literature (Appendix M), the committee concluded that the current and near future technologies for cellulosic biofuels could likely achieve a conversion yield of 70 gallons of ethanol equivalent for each dry ton of biomass. The committee ran the BioBreakeven model with that conversion yield and then performed the same analysis with a conversion yield of 80 gallons of ethanol equivalent per dry ton of biomass to account for any technology advancements between now and 2022.

Q2. Please provide your name and employing organization(s).

A2. Ingrid Burke; University of Wyoming.

Q3. Are you an officer or employee of, or otherwise compensated by, any other organization(s) that many have an interest in the topic of this hearing?

A3. No.

Q4. In the last three calendar years, including this one, have you been a registered lobbyist?

A4. No.

Q5. If you have worked as an attorney, contractor, consultant, paid analyst, or in any other professional services capacity, please provide a list of all of your firm's clients who you know to have an interest in the subject matter of this hearing. These should be clients that you have personally worked with in the last three calendar years (including the present year). Provide the name of the client, the matter on which you worked and the date range of that work. If there was a deliverable, please describe that product.

A5. None.

Q6. Please provide a list of all publications on which you have received an author or coauthor credit relevant to the subject of this hearing. If the list is extensive, the 10 most recent publications will be sufficient.

A6. List as follows:

Evans, S.E., Byrne, K.M., W.K. Lauenroth, and I.C. Burke. Long-term drought reduces the dominant species and increases ruderals in a semiarid steppe. In press, *Journal of Ecology*.

Evans, S.E., I.C. Burke, and W.K. Lauenroth (2011), Controls on soil organic carbon and nitrogen in Inner Mongolia, China: A cross-continental comparison of temperate grasslands, *Global Biogeochem. Cycles*, 25, GB3006, doi:10.1029/2010GB003945.

Gathany, M. and I.C. Burke. 2011. Post-fire soil fluxes of CO_2, CH_2, and N_2O along the Colorado Front Range. *International Journal of Wildland Fire*, in press.

Bontti, E.E., I.C. Burke, and W.K. Lauenroth. 2011. Nitrogen partitioning between microbes and plants in the shortgrass steppe. *Plant and Soil*, in press.

McHale, M.R., E.G. McPherson, I.C. Burke. 2007. The potential of urban tree plantings to be cost effective in carbon credit markets. *Urban Forestry and Urban Greening* 6:49–60.

Currie, W.S., M.E. Harmon, I.C. Burke, S.C. Hart, W.J. Parton, and W. Silver. 2010. Cross-biome transplants of plant litter show decomposition models extend to a broader climatic range but low predictability at the decadal time scale. *Global Change Biology* 16: 1744–1761.

Munson, S.M., T.J. Benton, W.K. Lauenroth, and I.C. Burke. 2010. Soil carbon flux following pulse precipitation events in the shortgrass steppe. *Ecological Research*, 25: 205–211.

McCulley, R.L., I.C. Burke, and W.K. Lauenroth. 2009. Conservation of nitrogen increases with precipitation across a major grassland gradient in the central Great Plains of North America. *Oecologia* 159(3):571–581.

Burke, I.C., W.K. Lauenroth, G. Cunfer, J.E. Barrett, A.R. Mosier, and P. Lowe. 2002. Nitrogen in the central grasslands region of the United States. *BioScience* 52(9):813–823.

Burke, I.C., W.K. Lauenroth, and D.G. Milchunas. 1997. Biogeochemistry of managed grasslands in the Central Grasslands of the U.S. Pages 85–102. *In* Paul, E. and K. Paustian, eds. Organic matter in U.S. agroecosystems. Lewis Publishers.

Responses by Ms. Margo T. Oge,
Director of the Office of Transportation and Air Quality, EPA

Questions Submitted by Chairman Andy Harris

Q1. Why did EPA only choose to require service stations to label E15 but not other gasoline ethanol blends like E10, E85, or other mid-level ethanol blends?

A1. As part of the E15 Misfueling Mitigation Rule, EPA proposed to label E15 and sought comment about whether to also label E10. Most commenters stated that there is no need to label E10 fuel dispensers. Since E10 is currently prevalent in the marketplace (over 90 percent of the market) and already familiar to consumers, EPA concluded that E10 labels are not needed to minimize misfueling with E15 and that the E15 label contains the information needed to steer consumers to the fuel appropriate for their vehicles. EPA also noted that adding an EPA label to E10 fuel dispensers may confuse consumers since most States already require labels for E10 fuel dispensers.

EPA also sought comment about whether to require labels for E85 and other mid-level ethanol blends. Public comments were split on that issue. The Agency decided not to require labels for those fuel dispensers because the Federal Trade Commission (FTC) already requires labels for pumps dispensing E85 and other alternative fuels, and the FTC is considering further labeling requirements for E85 and mid-level ethanol blends. EPA also observed that most E85 and mid-level ethanol blend dispensers already have signage that makes clear that they are appropriate only for flexible-fueled vehicles. In sum, EPA concluded that it was not appropriate to adopt labeling requirements for blends other than E15 at this time.

Q2. Why did EPA backpedal on the content and language on the warning label from the initial proposal to the final label that was announced in June?

A2. EPA adopted a final E15 pump label that reflects many commenters' suggestions and the Agency's consultation with consumer labeling experts at the FTC. The Agency determined that the final label effectively provides consumers with the key information they need to avoid using E15 in vehicles not covered by the partial waiver decisions without unduly alarming them. FTC experts advised that stronger warning language might result in consumers avoiding use of E15 in vehicles for which the fuel is appropriate under the waivers (i.e., MY2001) and newer light-duty vehicles).

Q3. Since 14 automakers wrote to Representative Sensenbrenner saying that their warranties will not cover E15, who will be at fault when a motorist misfuels?

A3. EPA cannot speak for auto manufacturers as to whether manufacturers' product warranties will cover the costs of any problems that result if a motorist misfuels. EPA's waiver decisions and labeling rule do not change the terms of manufacturers' warranty provisions. Under EPA's regulations governing emissions warranties, manufacturers may condition their emissions warranties on use of a particular fuel so long as the fuel is broadly available, and may deny an emissions warranty claim if use of a different fuel causes the problem. EPA does not have jurisdiction over other warranties that manufacturers may provide. However, manufacturers have a strong incentive to work with their customers to solve problems.

EPA believes that the misfueling mitigation measures the Agency has established will minimize the potential for misfueling. EPA also plans to work with stakeholders to monitor the entry of E15 into the marketplace and the effectiveness of the required misfueling mitigation measures so that any issues that develop may be addressed on a timely basis. In addition, representatives of ethanol producers are currently working with automakers, boat manufacturers, EPA, and others to develop public education materials that will provide consumers with additional information to help them make appropriate fuel choices for their vehicles and gasoline-fueled equipment.

Q4. When does EPA plan to register E15? What differences did EPA find between E10 and E15?

A4. The timing of registration depends on the actions of E15 manufacturers. Under the Clean Air Act, every fuel manufacturer that intends to introduce E15 must first register the fuel with EPA just as they need to register E10 fuels. To meet registration requirements, fuel manufacturers must submit an application that includes emission and health effects information as well as company-specific information.

Last year, the Renewable Fuels Association and Growth Energy submitted information and analysis for meeting the emissions and health information requirements

for registering E15. The Agency reviewed the information and identified a few gaps that the two associations then worked to fill. They made their final submission last month, and the Agency subsequently issued an evaluation document that finds that the submission would satisfy the emissions and health effects information requirements for a registration application for E15. The final submission and evaluation document considers the differences between E10 and E15.

As noted above, each E15 fuel manufacturer must register the fuel, and a complete registration application includes more than emissions and health effects information. Since EPA has evaluated the final RFA and Growth Energy submission, fuel manufacturers may choose to rely on that information to complete their applications, but they must also provide company-specific information. We review and, as appropriate, approve complete applications as they are received. As of April 2, we have approved 24 applications for ethanol for use in E15.

It is also important to note that, prior to marketing E15, there are other requirements under the E15 partial waivers that must be satisfied. These include submission, EPA approval, and implementation of a misfueling mitigation plan and a survey plan for reviewing implementation of labeling and other E15-related requirements. State and local fuel quality, safety, and other regulations may also apply.

Q5. E15 is not a legal fuel until it is registered with EPA. EPA indicates they have received an application for registration. Can you identify a timeline for making a decision to approve or not approve the fuel?

A5. As of March 16, 2012, EPA has received 18 applications to register ethanol for use in making E15. EPA's practice for all fuel registration applications is to review and act on them in the order they are received.

Q6. As part of the Tier 3 rulemaking later this year, will EPA propose to change the current certification fuel from E0 (e-zero) to E15? If this has not been determined yet, what factors will EPA consider in making this decision?

A6. As we look to set new vehicle emission standards, we are also considering changes to the test fuel used to certify them. The current test fuel is E0 and is no longer representative of in-use gasoline. We will be considering all the properties of gasoline, including the ethanol content that is expected to reflect in-use gasoline during and after the implementation time frame of the Tier 3 emission standards.

Q7. EPA completed consultations with a Small Business Advocacy Review Panel about the upcoming Tier 3 regulations on October 14. Why was this review panel necessary, what concerns were raised by the small businesses, and what changes has the Agency made to the proposal in light of those concerns?

A7. The Regulatory Flexibility Act, as amended by the Small Business Regulatory Enforcement Fairness Act, requires that the Agency convene a review panel for any rule subject to notice-and-comment rulemaking requirements that may have a significant impact on a substantial number of small entities. As we began the rulemaking process, we could not be certain whether the rulemaking would have a significant impact on a substantial number of small entities, so we decided to convene a SBAR Panel for the Tier 3 rulemaking. As we continued to develop the proposal, the Panel process enabled us to receive the views and recommendations of the Panel and small entity representatives. We are using this input and insights gained through the Panel process as well as prior Panels that we have convened to design the proposal from the outset in a way that is responsive to the concerns of small businesses. We have convened such a Panel in many of our major rules, and this has typically led to our providing flexibility for small entities, such as providing additional time to comply with the standards.

Q8a–b. EPA stated that it intends to publish the Tier 3 Proposed Rule in December 2011. EPA has also stated this rule will include regulatory streamlining provisions to satisfy the President's July 11th Executive Order. (a) If the Proposed Rule is delayed beyond the end of the year for reasons unrelated to the streamlining provision, would EPA still include these streamlining provisions in the proposal? (b) Would EPA drop these important streamlining changes in order to meet the self-imposed December deadline?

A8a–b. The streamlining provision will be included in the Tier 3 proposal, which clearly has been delayed beyond December of 2011. We are continually involved in a process of reviewing and updating our existing regulations to consider new information and to respond to changing circumstances. Sometimes these regulatory updates occur through stand-alone rulemakings, and sometimes for efficiency we include them with other major rulemakings, such as the Tier 3 rule. As we began the Tier 3 rulemaking process, we sought input from industry not only on potential Tier

3 vehicle emission and fuel standards, but also on aspects of our current regulations that could benefit from technical corrections, clarifications, and streamlining. The oil and auto industries both responded with a number of items that were candidates for updating. We ourselves identified a number of other areas. We are committed to following through with streamlining provisions as part of the Tier 3 proposal.

Q9. EPA has stated it has data that demonstrates a reduction in sulfur in gasoline from 30 ppm to 10 ppm will result in substantive reductions in nitrogen oxide emissions and decreased ozone formation. Yet, EPA has not provided data to support this position. Please produce the evidence to show that reductions in sulfur from 30 ppm to 10 ppm will result in substantive reductions in nitrogen oxides and atmospheric ozone formation.

A9. There is a large body of public literature on research which has shown significant impacts of gasoline sulfur on vehicle emissions. This will be included in the docket at the time of the Tier 3 proposal, along with our own emission testing and inventory and air quality modeling to support the potential Tier 3 sulfur standards.

Q10. Mr. Hilbert's testimony detailed the results of the DOE-funded study on the impacts of E15 on marine engines, essentially finding that E15 will severely damage if not destroy these engines. What is your message to the millions of boat owners that now risk severe engine damamge (and potentially safety issues) as a result of running on E15? And is EPA doing anything beyond the labeling mandate to assist boat owners and others at risk from misfueling?

A10. Based on our engineering assessment that marine and other nonroad engines, vehicles, and equipment (nonroad products) are generally equipped with less sophisticated emission controls that may not accommodate E15, EPA denied the waiver for all of those nonroad products, as well as for all motorcycles and heavy-duty gasoline-fueled engines and vehicles. Thus, E15 is not approved for use in these engines and vehicles. EPA's assessment was confirmed for marine engines by the recent report you cite from the National Renewable Energy Laboratory. The NREL study was conducted on an engine durability cycle designed to stress engines, and the engines used elevated ethanol levels throughout testing. We have no evidence that occasional misfueling would destroy engines. The main concern is habitual misfueling, most likely happening accidentally if there were no labeling requirement.

The partial waivers EPA granted to E15 include conditions that require E15 producers to implement misfueling mitigation measures, and a final rule EPA issued in June requires that E15 producers and marketers take several specific steps, including fuel pump labeling, to help minimize the potential for misfueling. We based the misfueling mitigation requirements on similar requirements that proved successful in transitioning the marketplace to ultra-low sulfur diesel (ULSD) fuel. In the E15 misfueling mitigation rulemaking, we also noted that E15 marketers may supplement the required labels with signs or other means of communication that provide additional information appropriate for their customers. In addition, EPA described the importance of an industry-led public outreach and education campaign like that undertaken for ULSD. Development of an E15 outreach and education campaign is now underway, and representatives of many stakeholders, including marine engine manufacturers, are participating, as is EPA. The Agency is committed to working with stakeholders to monitor the entry of E15 into the marketplace and the effectiveness of misfueling mitigation efforts so that we many address any issues that arise on a timely basis.

Q11. I understand that EPA will soon publish an annual rulemaking which will include an assessment of the cellulosic industry prospects for 2012. Will EPA's methodology in assessing the cellulosic standard prospects for 2012 incorporate lessons learned from the previous year's assessment in order to weed out the factors that caused EPA's projections to significantly overestimate the amount actually produced?

A11. The statute specifies that EPA is to project the volume of cellulosic biofuel production, in consideration of the projections from the Energy Information Administration, for the upcoming year and must base the cellulosic biofuel standard on that projected volume if it is less than the applicable volume set forth in the Act. Since these evaluations are based on evolving information about emerging segments of the biofuels industry, and may result in the applicable volumes differing from those in the statute, we believe that it is appropriate to establish the applicable volumes through a notice-and-comment rulemaking process. In making this determination, EPA did consider all relevant factors, including historical production trends.

Q12. The National Academy of Sciences report entitled "Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuels Policy" found that the RFS standards are unlikely to be met absent a surprise technological breakthrough or policy change. We are about to enter a dramatic ramp-up in required biofuel production due to the RFS—billions of additional gallons of biofuels that the National Academy says we we won't be able to produce. Does EPA have the authority to downwardly revise the overall RFS and will EPA exercise that authority?

A12. Under RFS2, if the projected volume of cellulosic biofuel production is less than the applicable volume specified in the Act, EPA must lower the applicable volume used to set the annual cellulosic biofuel percentage standard to the projected volume of production. When we lower the applicable volume of cellulosic biofuel in this manner, we are also authorized to lower the applicable volumes of advanced biofuel and/or total renewable fuel by the same or a lesser amount. EPA has lowered the volumes of cellulosic the past two years, but has not lowered the total advanced or total renewable fuel volume standards because we anticipate that non-cellulosic advanced biofuels will be available in adequate supply to meet these standards. If, however, in the future, as the advanced volume mandate increases, our analysis indicates insufficient volumes of non-cellulosic advanced biofuels will be available, the Agency could exercise its authority to lower by the same or a lesser amount the total advanced and total renewable fuel volumes.

Further, section 211(o)(7) of the Clean Air Act allows the Administrator of EPA, in consultation with the Secretaries of Agriculture and Energy, to waive the requirements of the national renewable fuel standard, in whole or in part, if the Administrator determines, after pulic notice and opportunity for public comment, that implementation of the RFS requirements would severely harm the economy or environment of a State, a region, or the United States.

Questions Submitted by the Chairman of the House Committee on Science, Space, and Technology, Representative Ralph M. Hall

Q1. In response to my letter dated July 25, 2011, Assistant Administrator Gina McCarthy stated that the Regulatory Impact Analysis (RIA) to the 2008 Ozone NAAQS standard indicated that Tier 3 tailpipe standards for new light-duty vehicles were needed to attain the standard. However, the RIA only mentions improved catalyst designs to achieve Tier 3 tailpipe standards for NO2 of 0.02 grams/mile, and it is silent on the need for additional controls on fuel properties. Can EPA cite where it states in the RIA that additional controls on fuel properties are needed? Can EPA demonstrate that this standard cannot be met with gasoline with an average sulfur content of 30 ppm, the current standard?

A1. The Ozone NAAQS RIA did not specifically mention sulfur control. However, EPA has determined that in order for vehicle manufacturers to achieve more stringent NO_2 tailpipe standards, they will need to employ advanced catalyst designs. These advanced catalyst designs are only effective when coupled with lower sulfur concentrations in fuel. In developing the Tier 3 vehicle standards, which will be based on improved catalyst designs, we have consistently looked at the vehicle and its fuel from a systems approach, such that the improved catalyst design and gasoline sulfur control are looked at together. Any proposal to reduce sulfur levels will include a demonstration of the need for lower-sulfur gasoline to enable the vehicle tailpipe standards contemplated in the NAAQS RIA.

Q2. In September, EPA published a preliminary review of recent ozone data and identified eight new areas that would be in non-attainment with the 2008 NAAQS standard. For the five areas outside California that would presumably benefit from a lower sulfur standard, what percent would reach attainment (due to the continued penetration of vehicles certified to Tier 2, which is still being implemented) before 2017, when the Tier 3 standards would presumably begin to take effect?

A2. EPA's preliminary review of recent ozone data, included in a September 22, 2011, memo from Gina McCarthy to the EPA Regional Air Division Directors, found that 52 areas monitor air quality that exceeds the 2008 ozone NAAQS. According to the memo, EPA's modeling indicates that approximately half of the 52 hypothetical nonattainment areas would attain the NAAQS by 2015 as a result of rules already in place. The memo goes on to say that Tier 3 vehicle and fuel standards, as well as other stationary source rules under development, "will ensure steady forward progress to clean up the Nation's air and protect the health of American fami-

lies, while minimizing and in many cases eliminating the need for States to use their scarce resources on local actions."

Q3a–c. It has come to the Committee's attention that there is a concern regarding certain blends of biodiesel, specifically, above five percent or B5. There have been reports in some States of diesel vehicles breaking down to blends of 11 percent or more. On the gasoline side of the fuels equation, EPA establishes a certification fuel and requires quality control standards. (a) Is there a similar certification fuel for diesel? (b) What quality controls does EPA have to ensure biodiesel meets appropriate specifications? (c) Since the use of biodiesel is a federal mandate, why are the States the only ones involved in ensuring the quality of biodiesel fuel?

A3a–c. (a) Biodiesel (B100) for use in motor vehicles is required to be registered under 40 CFR 79 as a diesel fuel. As part of registration, in accordance with the Clean Air Act, diesel fuel is also required to be "substantially similar" to the diesel fuel used to certify vehicles to emissions standards, or the fuel must have received a waiver approved under 211(f) of the Clean Air Act. However, we have not defined "substantially similar" for diesel, so we rely on the fuel meeting the ASTM D6751 standard for biodiesel or to be waived under the authority in 211(f) before it can be registered. We believe that biodiesel meeting ASTM D6751 is "substantially similar" to diesel certification fuel.

(b) EPA requires the biodiesel manufacturer to present a certificate of analysis showing that the biodiesel meets the industry quality standard as noted above.

(c) EPA's Office of Enforcement and Compliance Assurance conducts random and directed inspections of fuel production and dispensing facilities TKTKTK for compliance with our requirements for renewable fuels and gasoline and diesel fuel.

Questions Submitted by Representative Randy Neugebauer

Q1. The refining industry is already heavily regulated. Additional regulations, such as Tier 3, may cause some U.S. refineries to close. Has EPA addressed this issue? What does EPA believe will happen to gasoline supply in the case of U.S. refinery closures? How would higher gasoline imports be helpful to achieve energy security?

A1. There are many factors that contribute to the closure of refineries over time. The Energy Information Administration (EIA) data show that since 1982 there have been 154 net refinery closures as the refining industry, like any other industry, has continued to undergo the natural process of rationalization as it matures. Smaller, less efficient facilities have been replaced by larger facilities. During the period from 2003 to 2011, when the highway and Nonroad Ultra-Low Sulfur Diesel programs, Tier 2 gasoline sulfur control, gasoline benzene control, were all phasing in, EIA data posted on its Web site show a net of just two closures of refineries that were producing transportation fuels, far fewer than during any previous period. During this same time, the average size of U.S. refineries increased from 113,000 barrels per day to 123,000 barrels per day, and total U.S. refining capacity increased by six percent. In each and every rulemaking, we have provided considerable lead time, phase-in flexibility, and, as necessaary, case-by-case refinery economic hardship relief to ensure our regulations were not causing refinery closures. We have processed at least a dozen individual hardship applications to date. During these hardship discussions, not one company has ever said that they were closing because of our standards.

For these reasons, we are also confident that the Tier 3 regulations would not cause refinery closures. We are once again developing the program with considerable lead time, phase-in flexibility, and case-by-case hardship relief to minimize the impacts. We are aware of the results of a study by Baker & O'Brien for API suggesting the potential for four to seven refinery closures. However, this study did not model the Tier 3 program, but rather fuel scenarios from a previous Automobile Alliance study. Furthermore, a prior Baker & O'Brien study for API for the ultra-low sulfur nonroad diesel proposal back in 2003 contained similar dire projections of as many as 12 refinery closures and dramatic reductions in diesel fuel production, which would result in a need to import 640,000 barrels per day of diesel fuel. However, when we analyzed what actually transpired between 2005 and 2010 when the highway and nonroad diesel fuel programs phased in, refineries did not close; diesel fuel and distillate production did not decline. Some U.S refineries are competing favorably with the rest of the world, although some refiners on the East Coast exposed to heavy competition from product imports and from the Gulf Coast refiners have recently closed.

Q2. The EPA was required to conduct an anti-backsliding study by the summer of 2009 to examine the potential adverse air quality impacts of renewable fuel mandates. It is fairly clear that this report was intended to precede additional regulations, as its findings will be crucial to informing new regulatory decisions. However, the EPA has said it will announce the details of the study along with your Tier 3 regulations. Why has the EPA ignored the Congressional intent for the purpose and schedule of this study and subsequent regulations? How can the Agency justify promulgating Tier 3 rules without first publishing the anti-backsliding study?

A2. The primary driver for the development of the Tier 3 vehicle and fuel standards is the need for further control measures to help areas that aren't meeting air quality standards to achieve and maintain them and therefore protect public health. There are over 144 million people living in areas that are exceeding these standards. The EPA is developing Tier 3 standards for light-duty vehicles and their fuels using its general authority under Clean Air Act sections 202(a) and 211(c). The Tier 3 standards under development are not intended to be an anti-backsliding control strategy but instead are justified on their own as an important strategy to address ozone and other air quality problems.

We are also in the process of carrying out the anti-backsliding study as required under Clean Air Act sections 211(q) and 211(v) to assess the emission and air quality impacts resulting from the increased renewable fuel volumes required by Congress. The anti-backsliding study and Tier 3 overlap in some technical areas, as they both consider the impacts of fuels and vehicles on emissions, and both actions will utilize an assessment of how renewable fuels affect vehicle emission. While they are designed for different purposes, this technical overlap is why we are conducting the anti-backsliding study in the same time frame as our Tier 3 proposal. However, the Agency would need to move forward with Tier 3 standards with or without the anti-backsliding study.

Q3. Could you please detail options other than Tier 3 EPA assessed, if any, that could result in meeting the 2009 Ozone National Ambient Air Quality Standards (NAAQS)? Did EPA exhaust all other possiblities that could help us meet those standards, such as vehicle catalyst modifications?

A3. The Regulatory Impact Analysis (RIA) for the 2008 ozone NAAQS modeled a variety of potential control measures that would help areas attain the NAAQS, including controls on stationary, area, onroad mobile and nonroad mobile sources. The Tier 3 vehicle standards represent the "improved catalyst design" that is discussed in that RIA. In the analysis done for the RIA, all of these measures combined were necessary to bring areas into attainment with the 2008 NAAQS.

Q4. What is EPA's end goal with emissions? Do you believe that emissions should ultimately be entirely eliminated? For example, should sulfur levels reach zero parts per million? At what point are we at final and acceptable levels of emissions?

A4. EPA's goal, as established by the Clean Air Act, is for all Americans to have air quality that meets health-based standards. The Clean Air Act requires that EPA review the health-based air quality standards (such as the ozone NAAQS) every five years to ensure that the standards are requisite to protect the public health. Meeting the health-based air quality standards requires a joint effort by the States and EPA, through a combination of nationwide rules passed by EPA and local rules passed by State and local air quality management agencies.

Questions Submitted by Ranking Member Brad Miller

Q1. Ms. Oge, my colleagues and I are very worried aobut the economic crisis in the country. Mr. Greco and Mr. Williams both claim in their testimony that oil refineries will have to close because of the not-yet-proposed Tier 3 standard. The DOE study that Mr. Williams mentioned in his testimony did note that the "cost of compliance contributed to economic stresses that resulted in the shutdown of 66 refineries from 1990 through 2010," but the report did not state that compliance costs were the "significant" factor as Mr. Williams has stated. It seems to me there are a number of factors that could have contributed to the closure of refineries. What is your response to the statement by NPRA that EPA's rules have been a significant factor in the closure of 66 refineries since 1990?

A1. There are many factors that contribute to the closure of refineries over time. The Energy Information Administration (EIA) data show that since 1982 there have been 154 net refinery closures as the refining industry, like any other industry, has

continued to undergo the natural process of rationalization as it matures. Smaller, less efficient facilities have been replaced by larger facilities. During the period of 2003 to 2011 when the Highway and Nonroad Ultra-Low Sulfur Diesel programs, Tier 2 gasoline sulfur control, gasoline benzene control, and the renewable fuel standards were all phasing in, EIA data posted on its Web site shows a net of just two closures of refineries that were producing transportation fuels, far fewer than during any previous period. During this same time, the average size of U.S. refineries increased from 113,000 barrels per day to 123,000 barrels per day, and total U.S. refining capacity increased by six percent. In each and every rulemaking, EPA has provided considerable lead time, phase-in flexibility, and (as necessary) case-by-case refinery economic hardship relief to ensure our regulations were not causing refinery closures. We have processed at least a dozen individual hardship applications to date. During these hardship discussions, not one company has ever said that they were closing because of EPA standards.

For these reasons, we are also confident that the Tier 3 regulations, as well as the refinery sector rulemaking, will not cause refinery closures. For the Tier 3 rule, we are once again developing the program with considerable lead time, phase-in flexibility, and case-by-case hardship relief to minimize the impacts. We are aware of the results of a study by Baker & O'Brien for API suggesting the potential for four to seven refinery closures. However, this study did not model the Tier 3 program but rather fuel scenarios from a previous Alliance study. Furthermore, a prior Baker & O'Brien study for API for the ultra-low sulfur nonroad diesel proposal back in 2003 contained similar dire projections of as many as 12 refinery closures and dramatic reductions in diesel fuel production, which would result in a need to import 640,000 barrels per day of diesel fuel. However, when we analyzed what actually transpired between 2005 and 2010 when the highway and nonroad diesel fuel programs phased in, refineries did not close; diesel fuel and distillate production did not decline. Some U.S. refineries are competing favorably with the rest of the world, although some refiners on the East Coast exposed to heavy competition from product imports and from Gulf Coast refiners have recently closed. For the refinery sector rulemaking, we do not anticipate any refinery closures as a result of stationary source regulations. In line with the above discussion, refinery closures have resulted from such significant drivers as changes in demand for refined petroleum products, the addition of capacity in emerging markets, and the decrease in the price of other fuels (i.e., natural gas), not from regulating fuel quality.

Q2. When did EPA start considering Tier 3 standards, and why?

A2. EPA is continuously assessing motor vehicle emissions and how they affect air quality and public health, and also the development and application of vehicle and emission control technologies. As part of the regulatory impact analysis for the 2008 ozone NAAQS, we identified tighter vehicle standards as a control measure that would help areas attain the standard. We have been planning for such standards since that time.

Emissions from motor vehicles and their fuels contribute to public health issues that exist currently and are projected to continue in the future. Motor vehicles are an important source of the compounds that form ozone, particulate matter (PM), and nitrogen dioxide (NO_2). State and local areas need federal measures to reduce these motor vehicle emissions in areas where these emissions are a significant factor contributing to nonattainment of the health-based air quality standards. As EPA is moving forward to implement the 2008 ozone standard, we project that about half of the expected 52 nonattainment areas will need additional emission reduction—either from specific stationary sources of pollution or from motor vehicles—in order to attain and maintain the public health standard.

Federal measures to reduce motor vehicle emissions are a cost-effective strategy for attaining public health standards. As the States have been telling us (e.g., the National Association of Clean Air Agencies [NACAA] and the Northeast States for Coordinated Air Use Managment [NESCAUM]), without new federal vehicle standards, areas may need to adopt other controls on industrial sources or small businesses that are more costly.

Q3. Why was the National Association of Clean Air Agencies' (NACAA) cost estimate for a potential Tier 3 fuels program so much lower than API's estimate of costs of potential fuel controls? How do these compare to what EPA is considering?

A3. One of the primary reasons is that the NACAA cost estimate was based on an analysis of the potential Tier 3 standards, whereas the API cost estimate was of fuel scenarios from a previous Automobile Alliance study, the least stringent of which is still more stringent than what EPA is considering for Tier 3. Beyond this, the API study made several conservative assumptions which tended to inflate the

costs and impacts. As discussed in the response to question 1, this is consistent with prior studies' performance for API by the same contractor.

Q4. What technology advancements in alternative transportation fuels are currently being reviewed at EPA? Could these fuels impact the ability of the country to meet the RFS?

A4. EPA continues to evaluate new fuels and new technologies as part of its responsibilities to qualify new renewable fuel pathways under the RFS program. There are many fuels that offer the potential for use in meeting the RFS volume standards. Many fuels have already been approved and new ones are being approved on an ongoing basis. Just recently, EPA issued a direct final action to identify additional fuel pathways that the Agency determined meet the biomass-based diesel, advance biofuel, or cellulosic biofuel life cycle greenhouse gas (GHG) reduction requirement under RFS2. This rule, when finalized, will approve biofuels produced from camelina oil, energy cane, giant reed, and napier grass. It also includes an evaluation of renewable gasoline, biodiesel produced through alternative processing, and clarifies our definition of renewable diesel to explicitly include jet fuel.

Responses by Dr. Jay Kesan, Professor and H. Ross and Helen Workman Research Scholar and Program Leader, Biofuel Law and Regulation Program, Energy Biosciences Institute, University of Illinois College of Law

Questions Submitted by Chairman Andy Harris

Q1. In your view, did EPA adequately follow the Clean Air Act in granting partial waivers for E15?

A1. § 211 of the Clean Air Act states:

- "Effective upon November 15, 1990, it shall be unlawful for any manufacturer of any fuel or fuel additive to first introduce into commerce, or to increase the concentration in use of, any fuel or fuel additive for use by any person in motor vehicles manufactured after model year 1974 which is not **substantially similar** to any fuel or fuel additive utilized in the certification of any model year 1975, or subsequent model year, vehicle or engine under section 7525 of this title." [1]
- "The Administrator, upon application of any manufacturer of any fuel or fuel additive, may waive the prohibitions established under paragraph (1) or (3) of this subsection or the limitation specified in paragraph (2) of this subsection, if he determines that **the applicant has established** that such fuel or fuel additive or a specified concentration thereof, and the emission products of such fuel or fuel additive or specified concentration thereof, will not cause or contribute to a failure of **any emission control device or system** (over the useful life of the **motor vehicle, motor vehicle engine, nonroad engine or nonroad vehicle in which such device or system is used**) to achieve compliance by the vehicle or engine with the emission standards with respect to which it has been certified pursuant to sections 7525 and 7547(a) of this title. The Administrator shall take final action to grant or deny an application submitted under this paragraph, after public notice and comment, within 270 days of the receipt of such an application." [2]

Sub-Issues Raised by Rep. Andy Harris

Reliance on U.S. DOE Testing and Data by EPA

In your question, you state the following:

- In discussing EPA's decision to grant a waiver for mid-level ethanol blends in a recent article, you stated that the Clean Air Act "language makes it perfectly clear that the fuel waiver applicant bears the burden of establishing that the waiver fuel will not negatively affect vehicle and engine emissions control systems. Nonetheless, when the EPA conditionally granted" the E15 waiver, "it relied almost exclusively on data supplied by the U.S. Department of Energy as opposed to data and analysis submitted by the waiver applicants."

These excerpts are from an article of mine published in *Global Change Biology Bioenergy*.

A. Arguments Against EPA's Action

The language of the CAA explicitly states that the EPA should not grant a fuel waiver unless "the applicant has established" that the waiver fuel will not adversely affect the ability of emission control systems to achieve compliance with EPA's emissions standards. [3] Yet when EPA conditionally granted the E15 Waivers, it relied primarily on testing conducted by the U.S. DOE. Specifically, when the EPA published its first decision regarding E15, it stated:

- Growth Energy did not provide the necessary information to support a full waiver in several key areas, especially long-term durability emissions data necessary to ensure that all motor vehicles, heavy-duty gasoline highway engines and vehicles, highway and off-highway motorcycles, and nonroad products would continue to comply with their emission standards over their full useful life. In 2008, DOE began emissions durability testing on 19 Tier 2 motor vehicle models that would provide this data for MY2007 and newer light-duty motor

[1] Clean Air Act, 42 U.S.C. § 7545(f)(1)(B) (2010) (emphasis added).
[2] Clean Air Act, 42 U.S.C. § 7545(f)(4) (2010) (emphasis added).
[3] *Id.*

vehicles ("DOE Catalyst Study"). Consequently, **the Agency delayed a decision until the DOE test program was completed for these motor vehicles in September 2010**. EPA reached its decision on the waiver request based on the results of the DOE Catalyst Study and other information and test data submitted by Growth Energy and in public comments. EPA also applied engineering judgment, based on the data in reaching its decision. [4]

Additionally, when EPA summarized its findings with respect to the fuel effects it traditionally analyzes in considering fuel waivers (i.e., durability/long-term exhaust emissions, immediate exhaust emissions, evaporative emissions, materials compatibility, and driveability and operability), it repeatedly relied on the "DOE Catalyst Study" and pointed out the shortcomings of the data submitted by the applicant. [5] Moreover, when EPA deferred its decision on model years 2001–2006 light-duty vehicles, it again referred to ongoing DOE testing and stated that "EPA expects to make a determination for these motor vehicles shortly after the results of DOE testing is available." [6] While the EPA's decision pays some attention to the notion of relying on "test data submitted by Growth Energy" (amongst other sources), [7] it remains abundantly clear that the data submitted by the applicant, when standing alone, was insufficient to justify granting the E15 Waivers. As such, the applicant did not establish that E15 would not adversely affect emissions control systems. Since the CAA only authorizes the EPA to grant a fuel waiver after the Administrator "determines that the applicant has established" that the waiver fuel will not adversely affect emissions control systems, [8] the Administrator may have abused her discretion and acted in an arbitrary and capricious manner in conditionally granting the E15 Waivers.

B. Arguments in Support of EPA's Action

As an initial matter, since the CAA requires the Administrator of EPA to "determine[]" whether the requisite burden has been established before granting a fuel waiver, the statute clearly envisions the exercise of agency discretion. [9] Although the CAA makes it clear that the applicant ultimately bears the burden of proof in seeking a fuel waiver, it says nothing about what types of information EPA is permitted to rely on in reaching its decision. [10] Additionally, the CAA explicitly provides that EPA must engage in "public notice and comment" prior to issuing a fuel waiver decision. [11] If EPA is not permitted to rely on information gathered through public notice and comment (i.e., information not supplied by the applicant), then the process is pointless. Moreover, the E15 Waivers provide a prime example of why EPA should be permitted to rely on information other than that submitted by the applicant. If, for example, the CAA were interpreted as requiring EPA to deny the E15 Waivers because the applicant itself had failed to submit enough data to establish that the waivers should be granted, this would not have altered the results of the DOE testing, and the applicant would likely resubmit its application based on the DOE results, and EPA would be forced to begin the public notice and comment process all over again. It is clearly a more efficient use of resources for the EPA to base its fuel waiver decisions on all relevant information that is brought to light via the public notice and comment period. Finally, the CAA's reference to the fact that the applicant must establish that the waiver fuel will not adversely affect emissions control systems, could be explained as a hold-over from the waiver provision's previous version that did not require public notice and comment. [12] Since the previous wording of the waiver provision did not require notice and comment, this language was likely originally included as a means to specify that EPA was not required to establish the merits of a fuel waiver (i.e., the EPA's role is to merely make a decision based on information submitted by the applicant). As the CAA now explicitly requires public notice and comment, it would be an absurd result to interpret the waiver provision as precluding the granting of a waiver when the applicant

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[4] U.S. Environmental Protection Agency, Partial Grant and Partial Denial of Clean Air Act Waiver Application Submitted by Growth Energy To Increase the Allowable Ethanol Content of Gasoline to 15 Percent; Decision of the Administrator, 75 Fed. Reg. 68094, 68095 (Nov. 4, 2010) (emphasis added) [hereinafter *E15 Waiver I*].

[5] *Id*. at 68096-97.

[6] *Id*. at 68097.

[7] *Id*. at 68095.

[8] Clean Air Act, 42 U.S.C. § 7545(f)(4) (2010) (emphasis added).

[9] *See id*.

[10] *See id*.

[11] *Id*.

[12] Clean Air Act, 42 U.S.C. § 7545(f)(4) (2006).

fails to establish the requisite burden on its own but sufficient information is gathered from other public sources.

C. Explanation of the Quoted Excerpts From Our Article

The quoted statement from our article is presented out of context in Representative Harris' question. In our article, the statement is preceded by noting that "[i]f we unpack the CAA's fuel waiver language, some important and possibly misleading ideas emerge." As this article was intended for a non-legally trained audience, this portion of the paper was intended to compare and contrast the way a non-lawyer would read the plain language of the CAA with the way in which EPA administers the fuel waiver process. In doing so, we remain completely agnostic as to whether or not the EPA's approach is proper.

In another article of mine, *Making Regulatory Innovation Keep Pace with Technological Innovation*, we again mention this issue in an agnostic manner, but go on to opine that if the EPA continues to view DOE testing as the gateway to fuel waiver approval, then it would be beneficial for the DOE to begin conducting tests on emerging types of biofuels (e.g., biobutanol).

Conditionally Granting the E15 Waiver for Some Vehicles and Denying It for Other Vehicle/Engine Types (i.e., conditionally granting a "Partial Waiver")

In your question, you state the following:

- You also noted that EPA's decision to partially approve the waiver contradicted the Clean Air Act language that the "fuel has no adverse effects on the emissions control system in a variety of vehicle and engine types."

These excerpts are from an article of mine published in *Global Change Biology Bioenergy*.

- A. Arguments Against the EPA's Authority to Conditionally Grant a ″Partial Waiver″ (Quoted directly from U.S. Environmental Protection Agency, Partial Grant and Partial Denial of Clean Air Act Waiver Application Submitted by Growth Energy To Increase the Allowable Ethanol Content of Gasoline to 15 Percent; Decision of the Administrator, 75 *Fed. Reg*. 68094, 68143–44 (Nov. 4, 2010) (internal citations omitted)).

"As stated in EPA's notice for comment on the E15 waiver request, a possible outcome after the Agency reviewed the record of scientific and technical information may be an indication that a fuel up to E15 could meet the criteria for a waiver for some vehicles and engines but not for others. In this context, the Agency noted that one interpretation of section 211(f)(4) is that the waiver request could only be approved for that subset of vehicles or engines for which testing supports its use. We also stated that such a partial waiver for use of E15 may be appropriate if adequate measures or conditions could be implemented to ensure its proper use. EPA invited comment on the legal aspects regarding a waiver that restricted the use of E15 to a subset of vehicles or engines, and the potential ability to impose conditions on such a waiver.

We received a number of comments expressing opposition to a partial waiver based on a lack of legal authority under section 211(f)(4). Some of those same commenters, as well as others, also stated that EPA should first conduct and finalize a rulemaking under section 211(c) to mitigate the potential for misfueling and limit the types of mobile sources for which E15 may be used.

Many commenters pointed to the language in section 211(f)(4) and argued that the use of the word 'any' in the phrase 'will not cause or contribute to a failure of any emission control device or system (over the useful life of the motor vehicle, motor vehicle engine, nonroad engine or nonroad vehicle in which such device or system is used) to achieve compliance by the vehicle or engine,' means that if the waiver applicant has not established that the use of E15 meets the waiver criteria for any type of motor vehicle or nonroad product, then the waiver must be denied. Noting the statutory provision's use of the word 'any,' commenters asserted that should E15 cause or contribute to a failure of any emission control device to achieve compliance under any single circumstance, then the waiver applicant has not met the waiver criteria and the waiver must be denied in its entirety. Another commenter suggested that the word 'any' modifies 'emission control device' and that if an emission control device for any of the types of vehicles in the parenthetical language in section 211(f)(4) is implicated, then the waiver must be denied. Still another commenter suggested that 'In amending section 211(f)(4) in 2007 with enactment of the

Energy Independence and Security Act, Congress expanded the types of devices for which an applicant must establish that a fuel or fuel additive will not cause or contribute to a failure while retaining the prohibition of causing or contributing to the failure of 'any' device. With the expansion of section 211(f)(4), EPA is directed to only approve a waiver if all nonroad and on- road vehicles and engines would not be adversely affected.' Commenters asserted that the provision effectively required that there should be a 'general purpose' fuel. The commenters noted that EPA would contradict this direction if it failed to address impacts on any portion of the vehicles or engines. Essentially, the implication of all of these assertions is that EPA can only grant a waiver if all emission control devices in all types of mobile sources listed in the statute will not be adversely impacted by E15.

We also received several comments suggesting that if EPA desires to grant a partial waiver, it must first proceed under section 211(c) with a separate and full rulemaking to analyze the costs, benefits, necessary lead time, and the technological feasibility of a partial waiver. The commenters stated that this rulemaking should also include an analysis of the partial prohibition and controls on the use of E15 and include detailed regulatory requirements to ensure adequate control measures and to mitigate misfueling with E15. Commenters stated that the inclusion in section 211(f)(4) of 270 days by which EPA must act does not allow enough time to address all the necessary marketing and other issues and thus Congress could not have envisioned a partial waiver."

U.S. Environmental Protection Agency, Partial Grant and Partial Denial of Clean Air Act Waiver Application Submitted by Growth Energy To Increase the Allowable Ethanol Content of Gasoline to 15 Percent; Decision of the Administrator, 75 *Fed. Reg*. 68094, 68143–44 (Nov. 4, 2010) (internal citations omitted).

- B. Argument in Support of the EPA's Authority to Conditionally Grant a "Partial Waiver" (Quoted directly from U.S. Environmental Protection Agency, Partial Grant and Partial Denial of Clean Air Act Waiver Application Submitted by Growth Energy To Increase the Allowable Ethanol Content of Gasoline to 15 Percent; Decision of the Administrator, 75 Fed. Reg. 68094, 68144 (Nov. 4, 2010) (internal citations omitted)).

"Growth Energy and ACE stated that the Agency has the authority to grant a partial waiver or that EPA's authority for a partial waiver is a permissible interpretation of CAA authority, but that the evidence suggests a waiver for all vehicles and engines on the road today is appropriate.

We also received comment noting that the prohibition in section 211(f)(1) only applies to the use of any fuel or fuel additive in light-duty motor vehicles, indicating that the grant of the waiver of this prohibition under section 211(f)(4) is not dependent on findings with respect to nonroad products. The commenter further noted that although EPA has the authority and discretion to look at the effect of a fuel or fuel additive on nonroad products (in the context of examining impacts on motor vehicles), nothing in the statute or legislative history indicates that the amendment to section 211(f)(4) sought to limit EPA's discretion for issuing a waiver for motor vehicles. In light of Congress' decision in the Energy Independence and Security Act of 2007 to substantially increase the Renewable Fuel Standard Program's volume mandates, this commenter suggests that reading the word 'any' in section 211(f)(4) as amended by the 2007 Energy Act to apply to anything more than any emission control systems on the subset of motor vehicles would be at odds with Congressional intent.

Regarding EPA's authority to impose conditions on a waiver, we received comment stating that EPA has the authority to grant waivers subject to a broad range of conditions that ensure that the fuel or fuel additive will not cause or contribute to the failure of any emission control device or system. One commenter pointed to four of the eleven waivers EPA has issued since 1977 that have placed conditions on a waiver. In EPA's first waiver decision in 1978, the Agency discussed its authority to grant conditional waivers, noting that it may grant a waiver 'conditioned on time or other limitations,' so long as 'the requirements of section 211(f)(4) are met.' This commenter also points to the legislative history of section 211(f)(4) which makes clear that EPA has authority to grant conditional waivers. The 1977 Senate Report regarding section 211(f)(4) states: 'The Administrator's waiver may be under such conditions, or in regard to such concentrations, as he deems appropriate consistent with the intent of this section.' Senate Report No. 95–125, 95th Congress, 1st Session 91 (1977), pg 91."

U.S. Environmental Protection Agency, Partial Grant and Partial Denial of Clean Air Act Waiver Application Submitted by Growth Energy To Increase the Allowable Ethanol Content of Gasoline to 15 Percent; Decision of the Administrator, 75 *Fed. Reg*. 68094, 68144 (Nov. 4, 2010) (internal citations omitted).

- C. The EPA's Decision Regarding Its Authority to Conditionally Grant a "Partial Waiver" (Quoted directly from U.S. Environmental Protection Agency, Partial Grant and Partial Denial of Clean Air Act Waiver Application Submitted by Growth Energy To Increase the Allowable Ethanol Content of Gasoline to 15 Percent; Decision of the Administrator, 75 *Fed. Reg*. 68094, 68144–46 (Nov. 4, 2010) (internal citations omitted)).

"The issue before EPA is whether it is reasonable to interpret section 211(f)(4) as authorizing EPA to grant a partial waiver under appropriate conditions, as in today's decision. If Congress spoke directly to the issue and clearly intended to not allow such a partial waiver, then EPA could not do so. However, if Congress did not indicate a precise intention on this issue, and we believe that section 211(f)(4) is ambiguous in this regard, then a partial waiver with appropriate conditions would be authorized if it is a reasonable interpretation. EPA has considered the text and structure of this provision, as well as the companion prohibition in section 211(f)(1), and believes it is a reasonable to interpret section 211(f)(4) as providing EPA with discretion to issue this partial waiver with appropriate conditions.

It is important to put section 211(f)(4) in its statutory context. The prohibition in section 211(f)(1) and the waiver provision in section 211(f)(4) should be seen as parallel and complementary provisions. Together they provide two alternative paths for entry into commerce of fuels and fuels additives. The section 211(f)(1) prohibition allows fuels or fuel additives to be introduced into commerce as long as they are substantially similar to fuel used to certify compliance with emissions standards, and the section 211(f)(4) waiver provision allows fuels or additives to be introduced into commerce if they will not cause or contribute to motor vehicles and nonroad products to fail to meet their applicable emissions standards. EPA's authority to issue a waiver is coextensive with the scope of the prohibition—whatever is prohibited can also be the subject of a waiver if the criteria for granting a waiver are met. In addition, the criteria for each provision have similar goals. They are aimed at providing flexibility to the fuel and fuel additive industry by allowing a variety of fuels and fuel additives into commerce, without limiting fuels and additives to those products that are identical to those used in the emissions certification process. This flexibility is balanced by the goal of limiting the potential reduction in emissions benefits from the emissions standards, even if some may occur because a fuel or fuel additive is not identical to certification fuel or it leads to some emissions increase but not a violation of the standards. Together, these are indications that these provisions are intended to be parallel and complementary provisions.

The section 211(f)(1) prohibition has evolved over time. Initially it was adopted in the 1977 amendments of the Act, and was much more limited in nature. It applied only to fuels or fuel additives for general use, and was also limited to fuels or fuel additives for use in light-duty motor vehicles. EPA interpreted this as applying to bulk fuels or fuel additives for use in unleaded gasoline. The prohibition did not apply to other gasoline, or to diesel fuels or alternative fuels, or to fuel additives that were not for bulk use. It was thus relevant only to the subset of motor vehicles designed to be operated on unleaded gasoline.

In 1990 Congress amended the prohibition and broadened it. It now applies to 'any fuel or fuel additive for use by any person in motor vehicles manufactured after model year 1974 which is not substantially similar to any fuel or fuel additive utilized in the certification of any model year 1975, or subsequent model year, vehicle or engine.' This extended the scope of the prohibition to apply to all gasoline, to diesel fuel, and to other fuels such as E85. However, the concept of applying this prohibition based on the relevant subset of vehicles continues. For example, a diesel fuel that is introduced into commerce for diesel vehicles does not need to be substantially similar to gasoline fuel or other fuels intended for non-diesel vehicles. This is so even though Congress used the phrase 'substantially similar to any fuel or fuel additive utilized in the certification of any* * *vehicles or engine' (emphasis supplied). Clearly Congress did not intend the use of the term 'any' in the prohibition to always mean all motor vehicles or 100% of the motor vehicle fleet. Diesel fuel does not need to be substantially similar to the fuel used in the certification of gasoline vehicles, and E85 does not need to be substantially similar to fuel used in the certification of diesel vehicles. For example, manufacturers who want to introduce E85 fuel or fuel additives for E85 look to the certification fuel that was used for the subset of vehicles that were certified for use on E85.

In some limited cases, EPA has approved a fuel additive as substantially similar even when it is introduced into commerce for use in just one part of a single vehicle manufacturer's product line. For example, where a fuel additive is considered part of the emissions control system for a vehicle model and is certified that way by the vehicle manufacturer, then it is not a violation of the substantially similar prohibition for manufacturers of the fuel additive to introduce it into commerce for use in

just that very small subset of vehicles, as long as it is substantially similar to the fuel additive used in the certification of that vehicle model. In all of these cases, broad to narrow subsets of motor vehicles can be considered when deciding whether the introduction of a fuel or fuel additive for use by that subset of motor vehicles is in compliance with the prohibition.

EPA has in fact applied this construct of this provision in all of its past waiver decisions. EPA has previously said that it is virtually impossible for an applicant to demonstrate that a new fuel or fuel additive does not cause or contribute to any vehicle or engine failing to meet its emissions standards. Instead, EPA and the courts allow applicants to satisfy this statutory provision through technical conclusions based on appropriately designed test programs and properly reasoned engineering judgment. For example, the sample size in these test programs does not include all motor vehicles in the current fleet; the sample size is comprised of a statistically significant sample of motor vehicles that, once tested, will enable the applicant to extrapolate its findings and make its demonstration. EPA believes that this practice of focusing on a relatively small but representative subset of motor vehicles does not violate the statutory use of the word 'any' in this provision.

Since the waiver and the substantially similar provisions are parallel and complementary provisions, this clearly raises the question of whether a waiver can also be based on a subset of motor vehicles meeting the criteria for a waiver. EPA believes the text and construction of section 211(f)(4) supports this interpretation.

First, the term 'waive' as used in section 211(f)(4) is not modified in any way. Normally one would read this provision as a general grant of waiver authority, encompassing both partial and total waivers, as long as the waiver criteria are met. Second, the waiver criteria, like section 211(f)(1), have evolved over time. In 1977, the criteria were phrased as providing for a waiver when the fuel or fuel additive 'will not cause or contribute to a failure of any emission control device or system (over the useful life of any vehicle in which such device or system is used) to achieve compliance by the vehicle with the emission standards to which it has been certified.' This was not modified in the 1990 amendments. In EISA 2007, Congress amended the waiver criteria, providing for a waiver when the fuel or fuel additive will not 'cause or contribute to a failure of any emission control device or system (over the useful life of the motor vehicle, motor vehicle engine, nonroad engine or nonroad vehicle in which such device or system is used) to achieve compliance by the vehicle or engine with the emission standards to which it has been certified.' Congress uses the term 'any' in section 211(f)(4), as it does in several places in section 211(f)(1). One use of the term 'any' was deleted in the 2007 amendments, when the parenthetical was broadened to include consideration of nonroad engines and nonroad vehicles as well as motor vehicles. The term 'any,' however, has always been paired with the consistent use of the singular when referring to vehicles and emissions control systems—'the vehicle' and the emissions standards to which 'it' is certified, and the 'vehicle in which such device or system is used.' Certainly Congress did not state that the applicant has to demonstrate that the fuel or fuel additive would not cause any devices or control systems, over the useful lives of the motor vehicles or nonroad products in which they are used, to fail to achieve the emissions standards to which they are certified. If Congress had stated that, then it would be clear, as one commenter suggests, that EPA should only grant a waiver if all emission control devices in all the types of mobile sources listed would not be impacted by the fuel. But Congress did not state that.

Several aspects of section 211(f) thus support the reasonableness of EPA's interpretation. The prohibition and the waiver provisions are properly seen as parallel and complementary, and the prohibition properly can be evaluated in terms of appropriate subsets of motor vehicles, notwithstanding the use of the term 'any' to modify several parts of the prohibition. This clearly raises the concept of also applying the waiver criteria to appropriate subsets of motor vehicles. 'Waive' is reasonably seen as a broad term that generally encompasses a total and a partial waiver, as well as the discretion to impose appropriate conditions. The criteria for a waiver also refer to 'any' but the entire provision does not provide a clear indication that Congress intended to preclude consideration of subsets of motor vehicles when considering an application for a waiver. Finally, a partial waiver gives full meaning to all of the provisions at issue.

For example, in this case, granting a partial waiver means that E15 can be introduced into commerce for use in a subset of motor vehicles, MY2007 and newer light-duty motor vehicles, and only for use in those motor vehicles. For those motor vehicles, EPA is not making a finding of it being substantially similar, but E15 has been demonstrated to not cause or contribute to these motor vehicles exceeding their applicable emissions standards. It will also not cause any other motor vehicles or any other on- or off-road vehicles or engines to exceed their emissions standards since

it may not be introduced into commerce for use in any other motor vehicles or any other vehicles or engines. Thus, under a partial waiver, as the commenter suggested, all emission control devices in all the types of mobile sources listed will not be adversely impacted by the fuel. It can only be introduced into commerce for those vehicles and engines where it has been shown not to cause emissions problems; for other types of mobile sources, it cannot be introduced into commerce for use in such vehicles and engines. In concept, therefore, the combination of this partial waiver, with appropriate conditions, and partial retention of the substantially similar prohibition, has the same effect as when the criteria for a total waiver has been met—the fuel or fuel additive will only be introduced into commerce for use in a manner that will not cause violations across the fleet of motor vehicles and nonroad products. It can only be introduced into commerce for use in vehicles and engines where it has been shown not to cause violations of the emissions standards, and may not be introduced into commerce for use in other vehicles or engines.

EPA recognizes that a partial waiver raises implementation issues regarding how to ensure that a fuel or fuel additive is only introduced into commerce for use in the specified subset of motor vehicles. The discretion to grant a partial waiver includes the authority and responsibility for determining and imposing reasonable conditions that will allow for effective implementation of a partial waiver. In this case, EPA has conditioned the waiver on various actions that the fuel or fuel additive manufacturer must take. The actions are all designed to help ensure that E15 is only used by the MY2007 and later motor vehicles specified by the waiver. If a fuel or fuel additive manufacturer does not comply with the conditions, then EPA will consider their fuel or fuel additive as having been introduced into commerce for use by a broader group of vehicles and engines than is allowed under the waiver, constituting a violation of the section 211(f)(1) prohibition.

EPA recognizes, as several commenters have suggested, that EPA can impose waiver conditions only on those parties who are subject to the section 211(f)(1) prohibition and the waiver of that prohibition. These parties are the fuel and fuel additive manufacturers. Waiver conditions can apply to them but cannot apply directly to various downstream parties, such as a retailer who is not also a fuel or fuel additive manufacturer. This is one reason EPA is also proposing specific misfueling mitigation measures in a separate rulemaking under section 211(c), to minimize any risk of misfueling. This will also facilitate compliance with certain of the waiver conditions.

Many commenters suggested that before EPA can grant a waiver of any type under section 211(f)(4), the Agency must first issue a rule under section 211(c) that addresses the proper prohibition and control of a new fuel or fuel additive to the extent necessary before such fuel or fuel additive is permitted under section 211(f)(4). However, there is no mention of timing in these two statutory provisions and EPA believes it appropriate to consider the merits of a section 211(f)(4) waiver request on its face."

U.S. Environmental Protection Agency, Partial Grant and Partial Denial of Clean Air Act Waiver Application Submitted by Growth Energy To Increase the Allowable Ethanol Content of Gasoline to 15 Percent; Decision of the Administrator, 75 *Fed. Reg*. 68094, 68144–46 (Nov. 4, 2010) (internal citations omitted).

• D. Explanation of the Quoted Excerpts from Our Article

Again, the quoted statement from our article is presented out of context in Representative Harris' question. In our article, the statement is preceded by noting that "[i]f we unpack the CAA's fuel waiver language, some important and possibly misleading ideas emerge." As this paper was intended for a non-legally trained audience, this portion of the article was intended to compare and contrast the way a non-lawyer would read the plain language of the CAA with the way in which EPA administers the fuel waiver process (i.e., the statement was not intended to suggest that the EPA's approach "contradict[s]" the language of the CAA in a legal sense). In doing so, we remain completely agnostic as to whether or not the EPA's approach is proper. In another article of mine, *Making Regulatory Innovation Keep Pace with Technological Innovation*, we again mention this issue in an agnostic manner, but go on to opine that if the EPA is willing to conditionally grant a fuel waiver for use in some vehicles/engines and deny it for use in others, then the applicant should be permitted to *ex ante* specify which types of vehicles/engines it is seeking a waiver for and thereby mitigate the costs associated with seeking a fuel waiver (i.e., negate the need to incur the cost of testing the waiver fuel in the types of vehicles/engines that are not the subject of the application.

Responses by Mr. Bob Greco, Group Director for Downstream and Industry Operations, American Petroleum Institute

Questions Submitted by Chairman Andy Harris

Q1. What does API think ought to be done by the EPA to prevent the impending RFS "trainwreck," i.e., the coming encounter with the E10 blend wall and the severe shortage of advanced technology renewable fuels? What role could Congress play?

A1. Congress should amend EISA to align the mandated biofuels volumes with the capacity of the existing vehicle fleet to safely use them. Congress should give authority to and require EPA to adjust the RFS requirement when the annual volume of any renewable fuel anticipated for meeting the RFS in any given calendar year exceeds that which can be reasonably produced; delivered through existing infrastructure; and consumed as determined by original equipment manufacturers' warranties at the time of manufacture of the vehicle or engine.

Q2. The requirements in the Energy Independence and Security Act are driving us into the E10 blend wall. Will EPA's waiver to allow the use of E15 in today's automobiles be of any help in averting the coming confrontation?

A2. No, it will not. EPA prematurely waived Clean Air Act (CAA) requirements to allow ethanol blends of up to 15% for model year 2001 and newer cars and light trucks prior to the completion of comprehensive auto and oil industry studies on the vehicle safety, performance, and durability impacts associated with use of the new fuel. Should the driving public experience problems with their cars, the concern is that drivers could demand E0, which would make RFS compliance more difficult than it already is. Widespread consumer problems occurring because of the waivers (either misfueling non-road equipment and pre-2001 vehicle problems or 2001 and later model year vehicle problems) would put the entire renewable fuels program at risk. Even if E15 is eventually given a green light by auto manufacturers after completion of comprehensive research, it will take several years before E15 can be introduced into the marketplace due to other regulatory hurdles and necessary changes to retail station infrastructure.

Q3. I understand that, in addition to the Baker & O'Brien analysis of potential Tier 3 regulation impacts, there have also been other studies released that project some smaller economic effects. Could you provide some context to these studies and their methodologies? [1]

A3. We are aware of studies conducted by the consulting firm, MathPro, which analyzed the refining economic impacts of prospective gasoline standards, but MathPro in each of these studies used methodologies that are much less rigorous and realistic than the Baker & O'Brien analysis. [2]

The main flaws in the MathPro's analytical approach are in the areas of modeling methodologies and study assumptions:

- **Capital expenditure/refinery investment**: The MathPro approach does not account for the unique characteristics and challenges of individual refineries. Instead, MathPro treats an entire PADD as one large "notional" refinery, and implies that adding required refining capacity can occur at the same rate and economies of scale across all refineries within the PADD. This results in over-optimization and an underestimate of compliance costs.

In contrast, the Baker & O'Brien analysis employs a stepwise approach in its refinery-by-refinery economic assessment of investment required for compliance, modeling 112 refineries on an individual basis. The Baker & O'Brien analysis, which allows for refineries to shut down, makes an assessment of required new and expanded capacities.

- **Treatment of natural gas liquids and refinery operation costs**: The linear programming constraints and modeling assumptions employed by MathPro were unrealistic because they do not track how refineries are actually run. The constraints and assumptions forces the "notional" refinery to increase the amount of crude oil used to offset the volumes of gasoline lost from reducing

[1] Baker & O'Brien: "Potential Supply and Cost Impacts of Lower Sulfur, Lower RVP Gasoline," July, 2011.

[2] MathPro: "Refining Economics of a National Clean Gasoline Standard for PADDS 1–3," June 27, 2008; MathPro: "Refining Economics of a Single Octane National Clean Gasoline Standard," October 8, 2010; MathPro: "Refining Economics of a National Low Sulfur, Low RVP Gasoline Standard," October 25, 2011.

RVP. In reality, refiners may consider options which include reducing production of refined products or shutting down. The MathPro approach does not allow for refinery shutdowns, and recent history demonstrates that individual refineries have shut down. In addition, the MathPro model does not accurately account for how the petrochemicals marketplace will react to the excess natural gas liquids created by reducing gasoline RVP.

Q4. Are further reductions in the sulfur content of gasoline necessary to meet the 2008 Ozone National Ambient Air Quality Standards (NAAQS)?

A4. No. Nationwide concentrations of the key ozone precursor nitrogen dioxide (NO_2) have dropped about 35% over the last 10 years.[3] Additional mobile source reductions of NO_2 will occur with vehicle turnover because of existing gasoline and diesel fuel on-road requirements, mandated increased fuel economy standards, and reductions projected from recent diesel standards for off-road vehicles.[4] Stationary source NO_2 is projected to decrease with implementation of the Cross States Air Pollution Rule and achievement of existing requirements written into State Implementation Plans to meet ozone standards. There are a variety of options to reduce the NO_2 emissions and thereby reduce ozone, but further reductions of sulfur content in gasoline are not necessary to meet the 2008 ozone standards.

Questions Submitted by Ranking Member Brad Miller

Q1. What technology advancements have the blenders made in the four years since enactment of legislation mandating the current RFS to prepare for compliance with the standard? What technology advancements are planned for the future?

A1. Blenders have made significant changes to ensure that 10% ethanol gasoline can be sold in the majority of fuel in the country to give us the best opportunity to meet the biofuel volumes mandated in the RFS. Gasoline suppliers (blenders) have increased the use of rail and truck deliveries to their terminals to accommodate the increased volumes of ethanol. Since ethanol must be stored in separate tanks at terminals—it cannot be moved via pipeline due to technical concerns—suppliers have installed tanks or converted them from other fuel service to store the ethanol. They have also installed advanced automated equipment that ensures that ethanol can be efficiently and accurately blended with gasoline to make a product that meets the specifications and State and federal requirements.

However, as my testimony indicates, the blendwall is coming quickly, and our members have not been sitting idle. They have been conducting research to understand how to bring more biofuels to market. For example, research is ongoing to determine how to mitigate the technical concerns of moving ethanol in pipelines. If the results can be applied in areas where pipelines move product in the right direction, namely mid-continent to the east coast or to/ from marine terminals for transportation via barge, there could be improvements in efficiently moving fuel grade ethanol to market. But, of course, more ethanol simply exacerbates the blendwall problem. The technological solution is the development and commercialization of biohydrocarbons identical to those from petroleum sources that can be dropped into current petroleum products. To that end, the biofuels and oil industries continue to conduct research to create such a fuel. However, time is not on our side. Development of biohydrocarbons is seriously lagging and offers little promise of being available in time to avert the blendwall.

E15 is sometimes held out to be a solution. While the Department of Energy and API have completed research on the ability of the existing retail gasoline station equipment to store and dispense gasoline with greater than 10% ethanol, the results of this research show that there are serious issues with using any equipment that is not specifically listed for a 15% ethanol fuel (E15) and the majority of equipment was not built for that fuel. Beyond the technical issues associated with storing/dispensing E15, suppliers and station owners have concerns regarding selling E15 to the consumer. Other research on the vehicle shows that some cars and trucks will be damaged by E15, and 14 automobile manufacturers wrote letters to Rep. Sensenbrenner that their warranties would not cover damage that resulted from a vehicle that was refueled with E15. Taken together, there are significant concerns associated with storing and selling a fuel that has more than 10% ethanol that may require Congressional action to mitigate these concerns. Moreover, even if the green

[3] *http://www.epa.gov/airtrends/nitrogen.html*.

[4] By 2030, this program will reduce annual emissions of NO_2 by about 800,000 tons, and further reductions will be made after 2030; see: *http://www.epa.gov/otaq/regs/nonroad/420f08004.htm*.

light were given to E15 today, the blendwall is approaching faster than the ability of the industry to upgrade the infrastructure needed to accommodate the huge volumes that would be required to avoid it.

Responses by Mr. David Hilbert,
Thermodynamic Development Engineer, Mercury Marine

Questions Submitted by Chairman Andy Harris

Q1a–c. There have been some criticisms of the NREL report, specifically that it was a very limited study and tested only a few engines. (a) Are you aware of any plans by either the Department of Energy or EPA to conduct a larger study on the effects of higher ethanol fuel blends on marine engines? (b) If no other study is planned, are you aware of any other studies that are comparable to the one you conducted? (c) As an engineer, absent information beyond what was produced in this study, what is your opinion of the performance of marine engines running on higher ethanol blend fuels?

A1a–c. Despite the limited nature of the testing, several issues were identified. The most striking example of these issues was the failed exhaust valves on the 300 HP supercharged four-stroke engine. The exhaust valve failure mechanism observed in the testing on E15 fuel was not experienced previously in the tens of thousands of hours of engine testing during the development and validation of this engine family on E0 and E10 fuel. The previous experience with the development and validation of the 300 HP engine family were outside the scope of this specific study, but was certainly taken into consideration by the Mercury Marine engineering team when assessing the risk presented by the different fuel. Thus, it presented a new failure mode due to the change in fuel.

(a) Mercury Marine initially proposed a much more extensive program that totaled $3.8M and would have been a more comprehensive study. We were told by DOE and NREL that the only funds available for this testing were $300K–$400K. Mercury provided 50% cost sharing even though there was little incentive for us to do so. We are not aware of any larger studies being planned.

(b) A comparable study was conducted by personnel at Volvo Penta at the same time we at Mercury Marine were doing our study. It was also funded by the Department of Energy, and it tested one engine family: a 4.3 liter sterndrive based on a General Motors-derived engine. The results of that study can be found at *http://www.nrel.gov/docs/fy12osti/52577.pdf*. This study noted difficulty in starting the engine when operated on E15 fuel.

(c) The study showed that the 300 HP supercharged four-stroke engine had a major engine component failure and an increase in certain exhaust emissions due to E15 fuel. The 9.9 HP four-stroke engine showed a fuel system component material compatibility problem and also an increase in certain exhaust emissions due to E15 fuel. The 200 HP two-stroke engine suffered the failure of a major internal engine component that relies on the fuel to carry lubricating oil to it, which calls into question if the ethanol portion affected the lubrication of that component. The number of problems observed in this study compared with the small sample of engines tested would suggest that the performance of E15 fuel was unacceptable.

Q2. How many marine and other off-road or small engines could potentially be at risk of misfueling with E15?

A2. Higher ethanol blend fuels certainly create a risk to all marine engines currently in use. Virtually none of the marine engines currently in use were ever calibrated for higher ethanol blends. As the fuel blends keep changing, at some point the legacy engines can no longer tolerate the fuels and will certainly exhibit an increased failure rate. In addition, materials used in the older engines were not designed to tolerate ethanol fuels, and increasing the allowable ethanol concentration will likely only add to the problem.

The National Marine Manufacturers Association (NMMA) estimates there are 12 million engine-powered marine vessels in the U.S. with about 90% being gasoline engine boats. As to small engines, we have seen reports from such groups as the Outdoor Power Equipment Institute (OPEI) that estimate that there are more than 200 million legacy small engines in use in the United States. Other off-road and small engine categories should be addressed by those industries, so please defer to those organizations for further detail.

Q3. What is the estimated cost of replacing small engines that may fail or be damaged when using E15?

A3. For marine engines, outboards range from 2 HP to 350 HP and sterndrive engines range from 130 HP to over 1,000 HP. Replacement cost of individual engines can range from $500 to $15,000 for outboards and from $3,000 to $100,000 for

sterndrive engines. For other engine types for other engine categories, please defer to those organizations for further detail.

Q4. In the event that an E15 waiver is granted for off-road vehicles as well, in response, what would the marine engine manufacturing industry be doing to ensure its products are able to run safely and reliably on this higher blend? Are there additional costs to making marine engines resistant to the corrosion associated with higher ethanol blends, including E15? What technological advances would be required?

A4. To answer this question, I need to break this question down into several parts. First, I will treat the existing legacy fleet separately from newly manufactured engines. Second, I will speak to the technical difficulties, and then finally to the other aspects of this topic. The technical aspects will be centered around materials compatibility/corrosion resistance of the fuel system and also recalibrating the fuel system to supply the appropriate amount of fuel based on the fuel blend differences. There would likely be other technical challenges that would be discovered once the redesign process would begin, so the answer to this question is not meant to be all-encompassing.

- Legacy engines: Considering the millions of engines in the legacy fleet, there is no practical way to convert those legacy engines to operate on a fuel so very different from what they were designed to run on. To re-engineer 30+ years of service parts to have proper material compatibility, corrosion protection, and fuel delivery is simply impractical.
- Newly manufactured engines: Materials compatibility of the fuel system or any component that could come in contact with the fuel or fuel vapor (such as components that could be exposed to inadvertent contact with fuel during refueling or having fuel vapor cause problems) would need to be investigated and redesigned as necessary. Any type of elastomer, polymer, or sealant/adhesive must be subjected to "aggressive" ethanol blend exposure tests. Examples of these types of components would be gaskets, seals, o-rings, fuel hoses, etc. The "aggressive" ethanol blend refers to the fact that the fluid that the components are exposed to contains the proper chemistry to simulate real-world fuel with all of the contaminates, acidity, water content (including salt water), etc., that the engines will see. If the materials were found to be incompatible, more robust materials would need to be selected and then re-qualified with more bench tests and also running engine tests. The metal components, such as fuel reservoirs and fittings, must be tested for corrosion with the aggressive ethanol. If corrosion issues are found, the materials must be upgraded to metals with higher corrosion resistance or be coated with a corrosion-resistant coating, such as anodizing. The technology currently exists for the materials compatibility aspects, as evidenced by the use of Flex Fuel Vehicles in the automotive segment; however, the changes needed would likely increase the production cost of the engines.

Mercury Marine manufactures three different types of engines sold in the USA that need to be considered separately when discussing fuel mixture control. The fuel system would need to be recalibrated to supply the appropriate amount of fuel based on the ethanol blend, but this would present difficulty in accounting for the range of fuels from E0, which is still available, to E15. The three types of engines are: electronically controlled four-strokes, carbureted four-strokes, and direct fuel-injected two-strokes. The main considerations for recalibrating the fuel system are exhaust emissions, engine durability due to exhaust gas temperatures (example: broken exhaust valve in original study), fuel economy, and other operating characteristics.

Electronically controlled four-strokes offer the best potential for accepting E15 fuel. Electronically controlled outboard engines could be modified to include an oxygen sensor in the exhaust system to compensate for different fuels. On most outboard marine engines, the exhaust system is integrally cast into the cylinder block and cylinder head. The inclusion of a port for an oxygen sensor would mean that the block and/or cylinder head casting would have to be modified. There may also be other components that would need to be redesigned to make room for the sensor protruding out of the exhaust passage, which would also increase cost. The electronic engine controllers on many outboards would need to be redesigned to account for the additional sensor input, as well as developing and validating the software to control the oxygen sensor.

Most of outboard marine engines 30 horsepower or lower are carburated and cannot be calibrated to run optimally on E0 and E15 while still maintaining emissions compliance and acceptable operating characteristics. Common industry practice from

the small off-road engine manufacturers identifies a 10% ethanol blend tolerance window (example 0–10% or 5–15%) in which carburated engines can be calibrated. [See the testimony of Kris Kiser: "Statement of the Outdoor Power Equipment Institute before the Committee on Environment and Public Works— U.S. Senate," April 13, 2011]. The carburated engines cannot use an oxygen sensor since the fuel system is not electronically controlled. There is no obvious or easily implemented solution to deal with the carburated models to make them tolerant of a wide variety of fuel blends. The technology that would need to be developed to remedy this problem would be a closed-loop electronic fuel injection system that would be competitive to a carburator in terms of cost (very cost sensitive on these small engines), reliability, and ease of service.

Direct-injected two-stroke engines pose a different challenge. The nature of the direct injected two-stroke engine causes fresh air to bypass the combustion chamber and go directly to the exhaust. As such, an oxygen sensor in the exhaust system senses this fresh air and cannot reliably control the fueling rate on this type of engine at all speeds and loads. Therefore, there is no way to adjust for differences in fuel blends with an oxygen sensor in this type of engine. Some other means to provide sensor input into a closed-loop fuel controller to adjust for fueling differences would need to be developed.

To estimate the total cost to redesign the current product offering, retool the necessary changes, validate the changes with analysis and physical testing, and move into production is a complete study in and of itself. The $3.8 million proposal mentioned in the answer to question 1.a. above reflects the scope of the preliminary investigation into this topic. The end result could be hundreds of millions of dollars of investment and lost opportunities to develop other more competitive products. The end result would be products that cost more to produce due to the higher-grade materials needed and more sophisticated control systems.

- Other considerations: When considering new engine installations into new boats, in many cases the boat hull and engine are from different manufacturers. The boat hull often contains a large portion of the fuel system such as the fuel tank, fuel lines, etc. The boat manufacturers would also have to validate the fuel systems on new boats with E15 fuel.

Another point to consider is that many new marine engines are sold to replace worn-out engines in existing boat hulls. Even if the new engines are compatible with E15 fuel, the legacy boat in which they are installed may not be. There have been documented cases of older boat fuel systems which are incompatible with ethanol blended fuels. The legacy boat fuel system would need to be reevaluated to see if there are material compatibility issues. This would further exacerbate the issues of misfueling if there were some marine engines approved for E15 and others that were not and also some boat fuel systems which are approved for E15 and others that are not.

Q5. It has been suggested that the endurance and emissions problems you witnessed when testing marine engines with E15 would not occur with advanced biofuels. Why is that the case? What properties of advanced biofuels make them more suitable for use in a marine engine as compared with ethanol? Are there any studies available to support this suggestion?

A5. What are being proposed as "advanced biofuels" are synthetically made fuels that are nearly chemically identical to current gasoline, diesel, and jet fuels. As such, they would not have the higher oxygen content of ethanol fuels, would not cause enleanment of the engine which leads to the increased engine operating temperature, would not have the material compatibility issues, and not absorb water. All proposed fuels require extensive testing, but the characteristics proposed for these "drop-in" fuels suggest that they will behave very much like the petroleum fuels they would replace.

Questions Submitted by Subcommittee Ranking Member Brad Miller

Q1. Please provide your name and employing organization(s).

A1. David Hilbert—Thermodynamic Development Engineer, Mercury Marine Division of Brunswick Corporation.

Q2a. Are you an officer or employee of, or otherwise compensated by, any other organization that may have an interest in the topic of this hearing?

A2a. No

Q3a. In the last three calendar years, including this one, have you been a registered lobbyist?

A3a. No

Q4. If you have worked as an attorney, contractor, consultant, paid analyst, or in any other professional services capacity, please provide a list of all of your firm's clients who you know to have an interest in the subject matter of this hearing. These should be clients that you have personally worked with in the last three calendar years (including the present year). Provide the name of the client, the matter on which you worked and the date range of that work. If there was a deliverable, please describe that product.

A4. I was the technical leader of a test of E15 blend fuel in three different Mercury outboard engines. These tests were conducted at the Mercury Marine test facility in Fond du Lac in 2010–2011 by Mercury personnel under contract to the U.S. Department of Energy and coordinated by the National Renewable Energy Lab (NREL). The final report was released by the Department of Energy in October 2011. This test was entitled, "High Ethanol Fuel Endurance: A Study of the Effects of Running Gasoline with 15% Ethanol Concentration in Current Production Outboard Four-Stroke Engines and Conventional Two-Stroke Outboard Marine Engines," and it formed the basis for my testimony before the Subcommittee. It can be accessed on the Web site of DOE's National Renewable Energy Laboratory at the following URL: *http://www.nrel.gov/docs/fy12osti/52909.pdf*.

Q5. Please provide a list of all publications on which you have received an author or coauthor credit relevant to the subject of this hearing. If the list is extensive, the 10 most recent publications would be sufficient.

A5. "High Ethanol Fuel Endurance: A Study of the Effects of Running Gasoline with 15% Ethanol Concentration in Current Production Outboard Four-Stroke Engines and Conventional Two-Stroke Outboard Marine Engines"—as listed in question 4 above.

Responses by Mr. Jack Huttner,
Executive Vice President, Commercial and Public Affairs,
Gevo, Incorporated

Questions Submitted by Chairman Andy Harris

Q1a–1e. In your written testimony, you discuss Gevo's projections for estimated biobutanol production capacity in the coming years and out to 2015. You state that by 2015, Gevo plans to have approximately 350 million gallons on biobutanol production capacity at an estimated nine plants. (a) How much biobutanol is Gevo currently producing? (b) Could you please explain how the composition of EPA's pending Tier 3 standards may impact your projected production capacity? (c) Could you explain how this uncertainty over forthcoming standards has impacted your company and the industry in general? (d) What impact would the establishment of E15 as the new certification fuel for new tailpipe emissions standards have on Gevo's projected production capacity, the company's business model, and on the product's anticipated economic and environmental contributions? (e) What would be the broader impact for all fuel-based industries?

A1a–1e. As I stated in my testimony, Gevo currently is converting two existing ethanol plants for isobutanol production, with the first 18 million gallon per year (MGPY) facility expected to be online by mid-2012 and the second with an additional 38 MGPY in 2013. Until the first commercial plant is in production, Gevo is producing isobutanol at its one MGPY demonstration plant in St. Joseph, MI, as needed by customers for product specification and qualification. Gevo's business plan is to build on the success of these early biobutanol units and accelerate the conversion of ethanol facilities to biobutanol manufacturing plants to reach approximately 350 million gallons of production from nine biobutanol plants by the end of 2015.

EPA is not expected to propose its Tier 3 standards regulations until early 2012 and it is far from clear what the details on that proposal will be or whether the final Tier 3 standards—scheduled for adoption in late 2012 or early 2013—will be similar or significantly different from the proposal. With those caveats, however, EPA has conducted briefings with stakeholders regarding the direction of their Tier 3 Standards deliberations and, based on what Gevo has heard from EPA and other stakeholders, the proposal will have the following impacts on our projected production capacity and business plan.

EPA is expected to require reductions in gasoline sulfur levels in the Tier 3 proposal. Given biobutanol has almost no sulfur content, Gevo anticipates that gasoline standards requiring lower sulfur content will increase demand for a renewable biofuel such as biobutanol. Our product's extremely low sulfur content will make it a very attractive biofuel blendstock for refiners and other obligated parties under the projected Tier 3 standards.

EPA also has discussed reducing gasoline "volatility"—measured by Reid Vapor Pressure, or RVP, measured in pounds per square inch—under the Tier 3 proposal, to control ozone precursors. Biobutanol has a lower RVP than ethanol, again making Gevo's product a more attractive biofuel blendstock for obligated parties under the Tier 3 standards if RVP is restricted. However, in conventional gasoline areas of the country, Congress has allowed ethanol a "one-pound" RVP waiver for 10 percent ethanol/gasoline blends (so-called E10). This ethanol RVP waiver limits the effectiveness of EPA's RVP constraints in terms of environmental protection, and reduces the competitive advantage that biobutanol's inherently lower RVP should bring to its blenders in the marketplace. Thus, in a vacuum, Tier 3 standards that constrain RVP should be advantageous to Gevo and biobutanol. With the presence of the one-pound ethanol waiver, however, that advantage is minimized or eliminated.

A third matter EPA has floated as part of the Tier 3 proposal is changing the "certification fuel"—the fuel used to certify vehicles and engines to the Tier 3 emissions standards—from ethanol-free, "neat" gasoline (E0) to either E10 or E15. EPA posits that E10 is a prevalent gasoline blend sold across the United States today and that, given the Renewable Fuel Standard under the 2007 energy bill, E15 will be the prevalent gasoline blend sold across the country in the coming decade. Gevo has not taken a position on a re-designation of the certification fuel from E0, but we do have concerns about such a proposal.

Gevo is concerned that moving to a certification fuel containing a specific biofuel, such as ethanol, as would be the case with E10, would create barriers to entry for non-ethanol biofuels such as biobutanol and a competitive advantage for ethanol over advanced biofuels as the latter seek to penetrate the gasoline markets in the

coming years. Gevo continues to consider this matter and looks forward to reviewing the rationale that EPA will put forward in its Tier 3 proposal before taking a formal position on a re-designation of a certification fuel.

Uncertainty is anathema to any business, and that includes the motor fuels production and biofuels production industries. It is very difficult for any business to make a commitment to a new capital project, a plant expansion or conversion, or a new business partnership when the business does not know what environmental standards it will be required to meet in the future. Thus, the mere fact that EPA is considering these Tier 3 Standards injects a degree of uncertainty into our industry—an uncertainly that impacts Gevo in the same manner as every other biofuels manufacturer. I am not able to identify a specific project that Gevo has not undertaken, or a commercial relationship with a refiner or marketer that has not developed, due to the uncertainty caused by the pending Tier 3 Standards. One cannot prove a negative.

As noted in the response to 1(b) above, Gevo has not taken a position on re-designating the certification fuel at this time. We do have concerns about designating a biofuel such as ethanol as the "incumbent" renewable blendstock in gasoline, but it may be that such concerns can be ameliorated by EPA or by other circumstances. To Gevo, however, it does not make sense to designate E15—a fuel that is not yet registered by EPA and thus not legal to sell anywhere in the United States—as the certification fuel. Many vehicle and small engine manufacturers have stated on the record that their engines will not operate well on E15 and that they likely will not warrant repairs caused by use of E15. Thus, it is unclear whether E15 will ever enter the marketplace in substantial volumes. Given this uncertainty, EPA should not force engine manufacturers to certify their engines using a fuel that is neither widely used by nor widely available to consumers across the United States.

Gevo's concern with the designation of E10 as the emissions certification fuel is focused on preventing ethanol from converting 30 years of federal tax and production supports for ethanol into a virtual monopoly of the renewable biofuels blendstocks for gasoline in the coming months and years. Congress intended the 2007 Renewable Fuel Standard to be technology neutral. If designating E10 as the certification fuel runs afoul of that neutrality, then Congress should monitor EPA's actions very closely on this matter.

Q2a–2c. You state in your written testimony that you are "in the fairly early stages of discussion with the EPA and hope to resolve" . . . "the issue of finding a way to permit the commingling of E10 and butanol so that a new, lower Reid Vapor Pressure (RVP) biofuels can enter the market, lower evaporative emissions, and contribute to cleaner air." (a) Could you please characterize the nature of the "early stages of discussion" currently ongoing with the EPA? (b) What progress has been made on this issue? (c) What do you anticipate will be the upcoming stages of discussion and progress toward "technology neutrality" in the RFS2 that you emphasize elsewhere in your testimony?

A2a–2c. Gevo would characterize its discussions with EPA to date as preliminary, but positive and productive. Gevo has explained its concerns to EPA staff in Ms. Oge's office, but has not yet discussed the commingling issue directly with Ms. Oge. Her staff has acknowledged the existence of the commingling issue and that, unless EPA guidance is altered, the commingling restriction will present a hurdle to the introduction of biobutanol and other renewable, non-ethanol biofuels to the marketplace. Gevo looks forward to the continuation of these discussions with EPA in the near future and to achieving what I believe is a joint goal of environmental protection and eliminating a barrier to the widespread introduction of a variety of biofuels into the gasoline market in the coming decade.

Gevo has not had further discussions with EPA staff on this matter since the hearing, but expects to do so in the near future.

Congress and EPA must remain vigilant to protect the technology neutrality built into the RFS2 program. While the RFS2 is a government program, it is regulating for-profit business entities seeking sales and income for their companies and positive returns for their shareholders. Thus, some may be tempted to seek to skew current or future EPA regulations towards one particular biofuel technology, process or molecule in an attempt to gain a competitive and economic advantage through government regulation. Gevo opposes such tactics and urges Congress and EPA to resist such efforts when they occur. Ultimately, consumers will decide the "winners" and "losers" under the RFS2 program and legislators and regulators should not seek to substitute their judgment for the harsh but generally accurate judgment of the competitive marketplace.

Q3–3a. You briefly mention that Gevo continues to face challenges that relate directly to the conflicts and unintended consequences of the motor fuel standards that are the subject of today's hearing. You then limit your discussion of these challenges to the issues of commingling and that of the Tier 3 standards, and their specific relevance to Gevo. (a) From your perspective, could you please offer a broader assessment of these conflicts and unintended consequences, including issues directly related to your company, as well as a more general assessment of their impact on industry at large—and the subsequent impact on the U.S. economy?

A3–3a. Federal and state regulation of motor fuels is a patchwork quilt of statutes and regulations adopted over the last three decades with, at times, conflicting public policy goals in mind. These public policy goals have variously ranged from increased overall production to environment protection to energy security to decreased use of fossil fuels. No observer should be surprised that these conflicting goals have given rise to conflicts and unintended consequences as one program or regulation is overlaid by others. If one adds to this mix the fact that principles of federalism and history allow States to regulate motor fuels in ways that in some cases contradict federal law, then it actually surprising that the system works as well as it does.

With respect to federal and State regulation of biofuels and biofuels production, this patchwork quilt has been woven over several decades of good intentions into a complex web of incentives and mandates that may or may not be achieving today's public policy goals. Gevo encourages Congress and the States to review and to the extent necessary revise these statutes and regulations to promote renewable biofuels with the following common characteristics: (1) high energy content; (2) low environmental impact with respect to traditional criteria pollutants and greenhouse gases; and, (3) compatibility with the Nation's liquid transportation fuel infrastructure and existing motor vehicle and non-road engines.

Q4. Are you currently or do you have plans to use cornstarch in isobutanol production? If so, would this biofuel qualify as a second-general biofuel?

A4. Gevo's business model is to convert ethanol from cornstarch plants to produce isobutanol. This strategy is meant to leverage the installed capital base (14 BGPY) of the current generation ethanol industry to make a fermentation alcohol with better gasoline-blending characteristics. But, we can also convert cellulosic sugars into biobutanol when the technology to convert biomass becomes economically competitive. In other words, Gevo's production technology does not require the use of cornstarch to produce biobutanol, but currently cornstarch is the most economically competitive and fastest route to our volume objectives available to Gevo.

With respect to qualification as a "second-generation biofuel," I suspect this question refers to whether Gevo's biobutanol will be certified as an "advanced biofuel" under the RFS2 program. The short answer to this question is yes, if the biobutanol pathway could show a greenhouse gas (GHG) reduction of 50% compared to 2005 gasoline. Gevo can achieve the GHG reduction if we were to invest the capital necessary to power our plants with renewable energy rather than fossil energy sources. While the RFS2 restricts cornstarch ethanol from ever qualifying as an advanced biofuel, there is no such restriction on biobutanol.

Q5a–5b. When the RFS was passed in 2005 and expanded in 2007, wasn't the goal of Congress to move beyond food crops for fuel and instead use waste products and other non-food feedstocks to product second-generation biofuels like cellulosic ethanol? (a) Does the RFS2 create a situation in which corn-based ethanol has the competitive advantage? How does that work? (b) What recommendations do you have for changes in the RFS that would allow for increased production of advanced biofuels?

A5a–5b. Yes, that is Gevo's understanding. However, the development and commercialization of non-food feedstocks has not kept pace with the optimism inherent in the RFS2 statute's goals for advanced biofuels. Biobutanol is arguably, a second-generation biofuel, even if produced from grain derived fermentable sugars. It is a second-generation biofuel by virtue of its performance characteristics, i.e., its higher energy density, compatibility with existing infrastructure (engines, pipelines, dispensers) and its easy conversion into hydrocarbon fuels, like jet, diesel and gasoline.

Gevo does not believe that the RFS2 program, as passed by Congress, inherently advantages corn-based ethanol. Rather, corn-based ethanol's competitive advantage stems from 30 years of federal and State support for ethanol through tax, energy and environmental policies. In all, this governmental support runs into the tens of billions of dollars. We believe that if ethanol (one fermentation alcohol) is to be supported by public policy, the same support should also be available to other fermenta-

tion alcohols, indeed other biofuels, so they may compete with ethanol on their performance and price characteristics. Otherwise, ethanol policy is a competitive barrier to the entry of other biofuel molecules.

A technology-neutral RFS2, as Congress intended, would enable biobutanol a very good chance of challenging corn-based ethanol's current dominance of the renewable biofuel gasoline blendstock market in the coming years and decades.

Gevo does not have a comprehensive set of recommendations for RFS2 program changes to provide to the Committee, but again offers the following recommendations with respect to potential statutory changes to the RFS2 program and to future EPA implementation of the existing RFS2 program—Congress and EPA must promote renewable biofuels with the following common characteristics: (1) high energy content; (2) low environmental impact with respect to traditional criteria pollutants and greenhouse gases; and, (3) compatibility with the nation's liquid transportation fuel infrastructure and existing motor vehicle and non-road engines.

Questions Submitted by Ranking Member Brad Miller

Q1. Please provide your name and employing organization.

A1. Jack Huttner, Executive Vice President, Gevo, Inc.

Q2a. Are you an officer or employee of, or otherwise compensated by, any other organization(s) that may have an interest in the topic of this hearing?

A2a. Yes.

Q2b. If the answer to question 2a is "yes," please specify the organization(s) and the nature of your relationship with the organization(s).

A2b. I am the Vice Chairman of the Advanced Biofuels Association, which has an interest in the topic of this hearing, but receive no compensation from the Advanced Biofuels Association and I did not submit testimony on behalf of the association for this hearing. I am also on the governing board of the industrial and environmental section at the Biotechnology Industry Organization (BIO).

Q3a. In the last three calendar years, including this one, have you been a registered lobbyist?

A3a. No.

Q4. If you have worked as an attorney, contractor, consultant, paid analyst, or in any other professional services capacity, please provide a list of your firm's clients who you now to have an interest in the subject matter of this hearing. These should be clients that you have personally worked with in the last three calendar years (including the present year). Provide the name of the client, the matter on which you worked, and the date range of that work. If there was a deliverable, please describe that product.

A4. I am an employee of Gevo, Inc., and have no clients that may have an interest in the subject matter of this hearing.

Q5. Please provide a list of all publications on which you have received an author or coauthor credit relevant to the subject of this hearing. If the list is extensive, the 10 most recent publications will be sufficient.

A5. I have not authored or coauthored any such publications relevant to the subject of this hearing.

Appendix 2

Additional Material for the Record

ADDITIONAL MATERIAL FOR THE RECORD

LETTER TO CHAIRMAN ANDY HARRIS FROM DR. VIRGINIA H. DALE, MEMBER, NATIONAL ACADEMIES BIOFUELS PANEL

OAK RIDGE NATIONAL LABORATORY
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Environmental Sciences Division
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Email: dalevh@ornl.gov

October 31, 2011

Representative Andy Harris, Chairman
Subcommittee on Energy and Environment
2318 Rayburn House Office Building
Washington, D.C. 20515

Re: Energy and Environment Subcommittee Hearing - Motor Fuel Standards

Honorable Chairman:

The National Research Council (NRC) report "Potential Economic and Environmental Effects of U.S. Biofuel Policy" was released on October 4, 2011. The 423 page report is complex and quite detailed. As one of the report committee members, I find parts of the report to be misleading if the assumptions of the analysis are not considered.

As is always the case for NRC products, the report is a compromise among the largely academic committee members and is based on research published in the literature. By definition, the National Academy of Sciences and its reporting arm, the National Research Council, engage in the scientific process. Science is based on observations from which hypothesis are derived. It is difficult to conduct a scientific process when (1) the data are inadequate, (2) models are applied at scales inappropriate to the situation, or (3) key processes are not included in the theories. All of these limitations are applicable to current analyses of effects of biofuels.

Therefore, I have three recommendations for interpreting the NRC report. First, please read the details with care. The assumptions, scales, and caveats of analyses and results are critical to the interpretation and any extrapolation of the results.

Second, many of the results of the report are based on model projections that often do not recognize the importance of site-specific details (such as water, climate and soils) and assume unrealistic homogeneity in processes and patterns. Most drivers of land-use change and environmental implications are place specific. Some aspects of bioenergy systems are merely reflections of the model input assumptions and projections, and those models have not been validated for bioenergy systems. For example, indirect land-use change is estimated based on projections from global economic models that do not include known drivers of such changes (such as local governance, economic conditions, policies, socioeconomic forces, or environmental conditions). In other words, readers are

cautioned to not "believe" model projections but rather to treat them for what they are: implications of a set of specified scenarios and assumptions. While models can enhance understanding, they must be validated by empirical information, and, thus far, the empirical evidence provides little, if any, support for modeled projections of land-use change.

Third, readers should recognize that the report is not based on the most current information. For example, the results of the US Billion Ton Update were not considered in the NRC report, and, instead, outdated estimates of biomass production were used. In addition, the report does not include current information from bioenergy technology industries or ongoing government research.

Today's biofuel ventures are willing to take the risks inherent in a new industry despite many uncertainties and constraints. The eventual success of private enterprises for feedstock production, transport, conversion, delivery, and use of biofuels depend on contextual socioeconomic and environmental conditions. The answer to the question of what are the economic and environmental effects of biofuels is that "it always depends" on a broad set of preexisting conditions, trends and available options, with no one solution being the best for all situations.

Sincerely,

Virginia H. Dale

Virginia H. Dale
PhD Mathematical Ecology
Director, Center for BioEnergy Sustainability

CC: Mr. Miller, Mr. Hall and Ms. Johnson

LETTER TO HONORABLE LISA P. JACKSON, ADMINSTRATOR, ENVIRONMENTAL PROTECTION AGENCY, AND WHITE PAPER, FROM MITCH BAINWOL, PRESIDENT AND CEO, ALLIANCE OF AUTOMOBILE MANUFACTURERS



Mitch Bainwol
President and CEO

October 6, 2011

The Honorable Lisa P. Jackson
Administrator
USEPA Ariel Rios Building
1200 Pennsylvania Avenue, NW
Washington, DC 20004

RE: Changes to U.S. Retail Gasoline

Dear Administrator Jackson:

EPA has long recognized that vehicle technology and the fuel employed with that technology need to work in concert as an integrated "system" so that vehicles can operate efficiently and achieve the lowest technologically and economically feasible emissions targets. The prior Tier 2/LEV II rules coupled vehicle emission reductions with improved fuel quality. The upcoming Tier 3/LEV III rules that EPA and the California Air Resources Board are developing should continue this approach, also requiring cleaner fuels to be provided in the marketplace.

The Tier 3/LEV III rules should include a nation-wide retail gasoline sulfur cap of 10 parts per million (ppm). Excess sulfur "poisons" the catalyst, reducing its ability to remove exhaust emissions. Prolonged exposure to excess sulfur can permanently diminish the catalyst's effectiveness even after steps are taken to purge the catalyst of sulfur. Current Tier 2 gasoline sulfur caps, combined with broad compliance flexibilities (*e.g.*, allowing fuel producers to calculate averages across refineries), allow a wide and unpredictable range of actual sulfur content in the marketplace. Going forward, this situation will compromise automakers' ability to meet the upcoming Tier 3/LEV III standards and hinder the introduction of advanced technology systems needed to meet anticipated future fuel economy and greenhouse gas regulations.

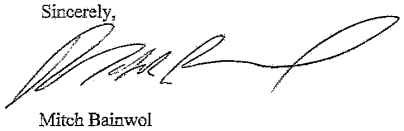
Currently, the U.S. ranks 46th globally in its gasoline sulfur limit. EPA's current standard is well behind the standards of Japan and the European Union, where sulfur levels in retail gasoline may not exceed 10 ppm. It is therefore timely for the U.S. to put a 10 ppm cap in place.

In addition to facilitating compliance with future vehicle requirements, a 10 ppm sulfur cap would immediately reduce emissions of vehicle sulfur oxides in the existing fleet by an estimated 15,626 tons per year. The exhaust emissions of legacy vehicles, current production vehicles and future production vehicles would all benefit, as would all on-highway and non-road gasoline engines, all large and small gasoline engines, and even stationary and mobile power sources.

Enclosed is our White Paper with an in-depth discussion of the need to reduce market gasoline sulfur. In addition to sulfur reductions, the Alliance supports reducing summer gasoline vapor pressure, a change that will help reduce overall mobile source emissions by decreasing evaporative emissions. Furthermore, to help achieve future requirements for the reduction of greenhouse gas emissions, we also recommend increasing the minimum market gasoline octane rating, commensurate with increased use of ethanol. Adding ethanol to gasoline increases its octane rating. To attain necessary octane levels, it is important that refiners not be permitted to reduce base gasoline octane ratings in light of the additional octane contribution from higher ethanol.

We would be happy to discuss our recommendations in more depth with you. If you or your staff have specific questions regarding these recommendations or any comments provided within this letter, please contact Julie Becker, Vice President for Environmental Affairs at the Alliance (202-326-5511; jbecker@autoalliance.org).

Sincerely,



Mitch Bainwol

MB/sf

Enclosures

cc: Gina McCarthy, Assistant Administrator, OAR
Margo T. Oge, Director, OTAQ

Alliance OF AUTOMOBILE MANUFACTURERS

August 24, 2011

ALLIANCE OF AUTOMOBILE MANUFACTURERS

WHITE PAPER:

WHY EPA TIER 3 MARKET GASOLINE SULFUR LIMITS NEED TO BE SIGNIFICANTLY LOWER, ESPECIALLY FOR MY 2017+ VEHICLES

Introduction

EPA is preparing to propose a new Tier 3 regulation by the end of 2011, one component of which would reduce the average level of sulfur in marketplace gasoline below the existing Tier 2 sulfur standard. The members of the Alliance of Automobile Manufacturers have been engaged with the Agency to express their vital interest in the content of the proposal, and to underscore support for a meaningful reduction in retail market fuel sulfur content nationwide.

EPA's current Tier 2 market gasoline sulfur standard essentially imposes three limits:

- 30 ppm maximum annual average at the refinery gate;
- 80 ppm per gallon maximum/cap at the refinery gate, measured on a batch basis;
- 95 ppm per gallon maximum/cap at the retail fuel pump.

The Tier 2 gasoline sulfur regulation was promulgated in 2000. Starting in 2004, for the six years of the implementation phase in, EPA provided a generous amount of flexibility to oil companies, including: corporate-wide averaging, inter-refinery trading, small refiner exemptions, a slower phase-in for Rocky Mountain region facilities, and a mechanism for hardship waivers, among others. In the aggregate, these have had the effect of "masking" some chronically high sulfur market gasoline supplies in certain areas, which cumulatively may have adversely affected vehicle catalyst performance and durability, and emissions in those markets.

The specific new Tier 3 vehicle emissions limits, and changes in fuel sulfur limits, are still in development. It has been suggested that EPA is considering reducing the individual refinery annual average maximum from 30 ppm to 10 ppm. However, EPA is also considering the implications of retaining the existing per gallon caps (80 ppm refinery gate; 95 ppm retail pump) versus lowering them (*e.g.*, to 20 and 25 ppm, respectively). This White Paper explains why a proposal to keep the 80/95 ppm Tier 2 sulfur caps is adverse to Agency goals for the auto industry.

It is also critical that in designing Tier 3, EPA not unduly delay uniform sulfur limits at the retail pump, by providing another set of flexible compliance measures to refiners as were used in Tier 2. The Alliance does not oppose flexibility for the oil industry *per se*, but the retail gasoline provided should be compatible with Tier 3 vehicle needs in order to meet both fuel

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www.autoalliance.org

economy/GHG requirements [including pending new limits for MY 2017[1]] and pending Tier 3 emissions reductions. The new lower sulfur fuel must be in the marketplace nationally for these vehicles in a timely manner to protect the vehicles, consumers, and the environment.

High sulfur cap limits and/or over-broad implementation flexibility (*e.g.*, in calculating averages across refineries) that allow a wide and unpredictable range of actual sulfur content among different geographic areas and over time, will handicap automakers' ability to introduce new advanced technology systems needed to meet the pending 2017 Fuel Economy/GHG regulations and maximize reductions in vehicle emissions. This approach would fail to treat the vehicle and the fuel as a system, and put an unfair proportion of the total regulatory burden on the auto industry.

Sulfur's Adverse Impact on Current and Future Emission Controls

Gasoline sulfur poisons all types of vehicle emission control devices and reduces their ability to reduce tailpipe emissions. For the three-way catalysts (TWC) used on nearly all existing gasoline-powered light duty vehicles in the U.S., the reduced efficiency caused by sulfur poisoning requires automakers to over-design their vehicles (if/when possible to do so) to meet emission standards. This over-design often involves the increased use of expensive and scarce precious metals in the catalyst, which ultimately makes the vehicle more expensive (and prone to catalyst theft). Furthermore, if the sulfur level is high enough, such design compromises may not be possible.

In all cases, even where over-design enables a vehicle to meet its emission standards, the actual emissions from a vehicle with a sulfur-poisoned catalyst will be higher than they otherwise would be. Since chronic sulfur poisoning may be only partially reversible, the impact on catalyst efficiency is cumulative. Thus, all conventional emissions—including HC, CO, NOx, PM and toxics—will increase as a result, depending on the amount and duration of the sulfur exposure. Sulfur also will affect the vehicle's fuel economy and greenhouse gas emissions adversely, due to the additional energy and operational steps that need to be taken to cope with the sulfur poisoning.

The reversibility of the poisoning, especially over time, in a vehicle chronically exposed to higher sulfur retail gasoline, is an important issue. When the Tier 2 regulation was adopted, it was believed that the sulfur poisoning could not be reversed without physically replacing the catalyst.[2] Over time, technology improvements did enable some reversibility, although at a cost of lower fuel efficiency.[3] Even so, sulfur will always cause at least some permanent impairment of the catalyst, and this impairment causes increased concern as the vehicle accumulates mileage, and as emission standards become more stringent. Under Tier 2, vehicles must continue to meet emission standards through 120,000 miles of driving, and the Tier 3 regulation is anticipated to require compliance with tougher standards of driving.

Reversing the sulfur poisoning requires very high temperature operation from time to time, but TWC subject to leaner exhaust hydrocarbon levels will have lower operational temperatures, making them easier to become and remain poisoned with sulfur. In addition, over time, repeated

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[1] New models are introduced during the previous calendar year, *i.e.*, MY 2017 vehicles are introduced during CY 2016.

[2] As a compliance measure, replacing the catalyst is prohibited.

[3] Removing sulfur from TWC requires increasing the fuel-air ratio and higher temperatures, among other things.

burn-off of the catalyst can damage the catalyst brick substrate, prematurely age it, and reduce catalyst durability.

Highway driving tends to produce higher exhaust temperatures than city driving, and if a vehicle is driven only in the city, its catalyst may not see the higher temperatures needed for sulfur burn-off, and as a result its emissions will be higher. Many, if not most, of these city vehicles will be located in ozone non-attainment areas. EPA should consider that many consumers may drive in a manner not conducive to catalyst burn off, yet are located in areas that need the emission reductions the most.

New technologies are under consideration as tools to help automakers meet stringent new fuel economy standards, and the significantly more fuel efficient, lean burn gasoline engine (compared to conventional engines) is one of these. This technology requires the use of different emission control devices, such as the Lean NOx Trap, similar to those used in diesel engines, to meet NOx emission standards. Lean NOx traps also have lower operational temperatures and will be more easily poisoned. These devices quickly and permanently lose their ability to function as the fuel sulfur level rises above 10 ppm.[4] Some of the individual automakers have already provided EPA with proprietary company-specific data on this point.

Recent Support for Reducing Sulfur: SAE 2011-01-0300, D. Ball, et al., *Effects of Fuel Sulfur on FTP NOx Emissions from a PZEV 4 Cylinder Applications*

Test data on sulfur's impact on very low emitting vehicles (*e.g.*, SULEV, PZEV, and Tier 2-Bin 2) remain scarce, especially at ultra-low sulfur levels and over a 150,000 mile compliance lifetime. This recent SAE study provides some insight. The authors measured the impact of test fuels containing 3 ppm and 33 ppm sulfur on NOx emissions from a 2009 MY PZEV Malibu. One important aspect of the evaluation was measuring the ability of different driving cycles to reverse the catalyst poisoning, and the potential for "NOx creep", *i.e.,* the incremental permanent reduction in catalyst efficiency as a result of repeated sulfur exposure. As the study notes, catalyst efficiencies for PZEVs need to exceed 99.4% for HC and 99.3% for NOx through 150,000 miles, and small changes in catalyst efficiency can have a large impact on tailpipe emissions.

The study found that sulfur levels of 33 ppm will affect "test to test" NOx stability during FTP testing, and that catalyst temperatures of 600°F, common in under-floor catalysts, can allow sulfur poisoning that affects NOx reduction efficiency and consistency of results. Using the US06 test cycle (high engine flow, high load) between FTP cycles, however, can increase catalyst temperature enough to help reverse the poisoning and improve "test to test" stability. According to the study, while the US06 can help mitigate sulfur poisoning, using a 3 ppm sulfur gasoline would eliminate the need to use such a cycle -- also, a 3 ppm fuel would reduce NOx emissions by 40% compared to the 33 ppm fuel, and/or allow lower levels of precious metals in the catalyst.

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[4] In 2000, the Association for Emissions Control by Catalyst (AECC) found: "The promising NOx adsorber technology that diesel and lean burn engines need requires sulphur levels significantly below 10 ppm. This will avoid compromising the lower fuel consumption and CO2 emissions by requiring frequent regeneration to remove the sulphur that is clogging the NOx adsorption capacity. See *Response to European Commission Consultation on the Need to Reduce the Sulphur Content of Petrol and Diesel Fuels below 50 parts per million*, July 2000, available at http://www.aecc.eu/en/Publications/Archive.html.

Lessons from Tier 2 US Gasoline Sulfur Regulation

Automakers found Tier 2 vehicle emission regulations much more stringent than expected, which in turn strengthened their call for the lowest possible gasoline sulfur levels. The Agency's choice of nominal 80 ppm/95 ppm sulfur caps for Tier 2 was already a much bigger compromise than should have occurred.

In addition, EPA's Tier 2 implementation scheme allowed sulfur levels to be significantly higher in the marketplace than the nominal legal limits for a considerable period after the rule's adoption. Besides giving most refiners two years after the 2004 effective date to phase in to the standard, the Agency gave an additional two years to small refiners and those in the Rocky Mountain region, and refiners could apply for hardship waivers that would allow an additional two years to comply. Thus the rule actually allowed six years to fully phase in the new fuel quality, with no provision to prevent local high sulfur areas during this period.

Moreover, EPA's 30 ppm limit was reached by averaging all batches *over a full year*, compared to California's low sulfur regulation (RFG Phase 2, implemented in 1996) which required averaging over a six month period. EPA imposed its 80 ppm per gallon cap at the *refinery gate,* and allowed retail gasoline to reach a 95 ppm cap at retail (and even this limit did not become absolute until 2011). California's Phase 2 regulation imposed its 80 ppm per gallon cap *at retail.* In its North American Fuel Survey (NAFS) the Alliance of Automobile Manufacturers was still finding U.S. retail gasoline with sulfur as high as 148 ppm in the summer of 2010.[5] While automakers would strongly welcome a significant lowering of average sulfur levels, they are greatly concerned about the possibility of high sulfur "hot spots" persisting at various retail points around the country if high caps are still allowed.

It is unclear when EPA will next revisit the issue of sulfur market fuel specifications, so the Agency should propose limits that will enable nationwide introduction of all emerging vehicle technologies for the foreseeable future.

Implications of Retaining the Tier 2 Sulfur Caps

Even with a much-needed, much lower annual sulfur average per refinery in place by 2016 (for MY 2017 vehicles) (and assuming no Tier-2 type averaging flexibility), retaining the *current* Tier 2 sulfur caps (80/95 ppm) in Tier 3 would be extremely problematic for autos, given the challenges of the 2017-2025 Fuel Economy/GHG rule and pending Tier 3 vehicle emission standards. Even if EPA reduces the refinery annual average sulfur limit considerably below the current 30 ppm, the prospect of continuing to allow up to 95 ppm sulfur *retail* gasoline in the marketplace means consumers in some locations will be buying relatively high sulfur fuel for their vehicles, some of them on a regular basis.

In addition, automakers are very concerned about repeated exposure of such vehicles to high sulfur levels, because the accumulation of sulfur on their catalysts over time and miles will put them at an unfair (and unpredictable) disadvantage for in-use compliance testing. Under Tier 2

[5] The Alliance of Automobile Manufacturers North American Fuel Survey (NAFS) conducted in the summer of 2010 found regular gasoline in Kansas City containing 148 ppm sulfur. However, the first NAFS survey for 2011 (conducted in January 2011) showed all gasoline samples apparently compliant with the 95ppm sulfur retail standard.

standards, vehicles must comply with emission standards for 120,000 miles of driving (and many vehicles are in Sec. 177 states requiring *California* emissions limit compliance for 150,000 miles, but which are exposed to *federal* fuels rather than the benefit of California fuels). Under the Tier 3 rule, automakers anticipate that all vehicles will be required to comply with tighter emissions standards. Many will need to comply with the longer California useful life criterion. In addition, long-term usage patterns (e.g., predominantly urban driving versus high-load highway driving) will differently affect catalyst performance and durability. Adding the element of unpredictable levels of market fuel sulfur (geographically and over time) could affect future in-use testing results, especially if no sulfur preconditioning steps are applied.

Vehicles have reduced catalyst efficiencies during and after chronic higher sulfur exposures, and this can cause significantly higher emissions. Poor or incomplete reversibility will cause ongoing higher emissions wherever the vehicle travels, including ozone non-attainment areas. Furthermore, future gasoline is likely to contain more ethanol, which contributes to higher NOx emissions, so higher sulfur gasoline will exacerbate the likelihood of an emissions increase. These combined effects would set back state efforts to meet stringent ozone ambient air quality standards. Importantly for the states and the general public, even occasional vehicle exposures to sulfur levels as high as 95 ppm will cause significantly higher HC, NOx, PM and toxic emissions than the design capability of vehicles. As a result, EPA will risk failing to prevent air quality backsliding, which Congress required EPA to study specifically out of concern about ethanol's impact on emissions.[6]

Allowing retail sulfur levels as high as 95 ppm also will inhibit the introduction of new fuel efficient, lean burn gasoline engine technology, as already publicly noted by some automakers. These engines are capable of providing significantly improved fuel economy and greenhouse gas benefits compared to conventional engines, but they require emission control devices that are quickly poisoned as the fuel sulfur level rises above 10 ppm.

Countries and regions that have capped gasoline sulfur at 10 ppm (for example, Europe and Japan) have been able to enjoy the benefits of lean burn technology over the past decade. If EPA retains the 95 ppm retail cap, U.S. consumers will continue to be deprived of this fuel efficient option, and they will continue to wonder why other countries seem to have more advanced and a greater diversity of fuel efficient technologies than the United States.

Maintaining a 95 ppm retail sulfur cap would be damaging to the U.S. reputation as a leader in air pollution control because so many other countries and some cities have already achieved ultra-low sulfur levels in their gasoline.[7] In Canada, for example, according to the Alliance's North American Fuel Survey, the highest sulfur level recorded last summer (2010) was 32 ppm for regular grade and 20 ppm for premium, and since 2007, the levels there have been consistently below 40 ppm. In Mexico all premium grade samples in the Alliance surveys have had less than 52 ppm sulfur since 2007. In half of the cities sampled, regular grade samples have had less than 80 ppm sulfur since 2009.

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6. See 42 USC 7545(q). Though due in draft form by 2009, this analysis has not yet been published. EPA expects to work on this analysis in parallel with drafting the Tier 3 Proposed Rule.

[7]According to Hart's International Fuel Quality Center, as of May 2010, Japan, South Korea, Iceland, Greenland, and the countries of the European Union require less than 10 ppm sulfur gasoline. The U. S. ranks 44th in a ranking of the top 100 countries by gasoline sulfur standard stringency. *See* PR Newswire, "IFQC Ranks Top 100 Countries by Gasoline Sulfur Standards: Europeans' Major Progress Bumps U.S. to 44th Place," May 5, 2011, and IFQC, http://www.ifqc.org/NM_Top 5.aspx.

Automakers that engineer vehicles for the U. S. have waited a long time for lower fuel sulfur levels that harmonize with foreign standards, enable lean-burn technology, and make full use of advanced technologies. Maintaining existing U.S. high sulfur caps would inhibit needed technology and international harmonization of fuels and vehicle design, and waste scarce economic and commodity resources on over-sophisticated emission control systems.

Flaws in the Purported Reasons for Retaining the Tier 2 Sulfur Caps

The main argument against more stringent sulfur limits boils down to concern that a few, perhaps older or small refineries that supply U. S. retail gasoline might be unable to consistently produce a lower sulfur product.

This argument seems weak, given how long refiners have known about sulfur's effects and have been producing lower sulfur gasoline. As noted, California began requiring a low sulfur gasoline in 1996. In 1998 EPA imposed Federal RFG Phase 2 requirements—affecting about one third of the country's gasoline market. To comply with federal RFG2's required NOx reductions, refiners needed to substantially reduce sulfur. As a result, by 2000, refiners were well on their way to producing Tier 2 compliant gasoline, as shown in EPA's Fuel Trends Report 2008, which studied retail sulfur levels from 1995 to 2005. By 2005, several years after Federal RG2 implementation and one year after Tier 2 implementation, the Federal RFG summer retail average had already dropped to about 70 ppm from about 200 ppm in 1998. The annual average for all gasoline in 2005 was 92 ppm. It is very difficult to conclude that a lower sulfur retail limit would not be feasible in the U.S. A few stressed refineries should not drive the universally applicable prospective federal limits.

A second argument is that contamination during distribution through the finished product pipeline infrastructure contributes to retail gasoline sulfur levels and that this contamination cannot be further controlled. The Alliance would appreciate the opportunity to see what current data EPA or other stakeholders have, including any comparisons of past versus current samples showing the relative magnitude of sulfur contamination levels, or that support the need for a 95 ppm sulfur retail cap.

The same contamination concerns were voiced when EPA was developing the ultra-low sulfur diesel (ULSD) fuel standard in 2002. Yet the country has successfully converted to retail 15 ppm sulfur diesel fuel nationwide, using the same pipelines to distribute the fuel as used for gasoline. Further, since the 2002 ULSD rule, EPA has greatly reduced the sulfur levels in other petroleum products that move through the pipelines. Non-highway diesel fuel and fuel used for locomotive and marine applications will have to meet the same 15 ppm sulfur limit by 2014, before Tier 3 is implemented. Thus, it should be much easier to move ultra-low sulfur gasoline in pipelines in 2016-17 than it was in 2006, when ULSD began its phase-in. In addition, since most gasoline today contains 10% ethanol, the sulfur levels are further reduced (diluted) during blending after the fuel leaves the pipeline, which also provides refiners with some flexibility.

EPA Opportunity to Promote International Harmonization Regarding Sulfur Levels

The 2000 edition of global automakers' Worldwide Fuel Charter stressed the need for sulfur-free gasoline. Shortly afterward, Europe and Japan started moving toward a 10 ppm maximum sulfur standard. Both of these markets have now had ultra-low sulfur gasoline for several years. Other countries, including Canada and Mexico, also are moving to well below 80 ppm[8] consistent with

[8] Based on retail sulfur levels measured through the Alliance North American Fuel Survey, 2007-2011.

the goals of the UNEP-managed Partnership for Clean Fuels and Vehicles, in which both EPA and the oil industry participate.[9] In 2005, the PCFV conservatively recommended a 50 ppm sulfur limit for all countries, even those in Africa, while recognizing the benefits of further reduction, but keeping in mind the challenge presented for developing countries.

Conclusion

EPA should use its opportunity in Tier 3 to provide a strategy toward achieving a 5-10 ppm cap on sulfur in U.S. retail gasoline. Any issues relating to particular refinery capability, pipeline, or other sulfur contributions should be addressed individually, as part of the larger strategy to achieve this goal, but should not be used to change the goal itself. Allowing sulfur caps as high as 80 ppm at the refinery gate and 95 ppm at retail pumps to continue indefinitely in the US marketplace is unwarranted, would handicap maximizing vehicle emission reductions and achieving fuel economy and GHG standards, and would inhibit development and use of cleaner, more efficient combustion technologies.

The Alliance looks forward to additional opportunities to work with EPA and other stakeholders on the gasoline sulfur reduction challenge.

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For additional information, please contact:

Valerie Ughetta, Director, Automotive Fuels
Alliance of Automobile Manufacturers
vughetta@autoalliance.org

[9] *See* Partnership for Clean Fuels and Vehicles, http://www.unep.org/transport/pcfv/partners/partners.asp); and Low Sulphur Campaign, http://www.unep.org/transport/pcfv/corecampaigns/campaigns.asp#sulphur). In 2005, the Partnership recommended that countries aim "To reduce sulphur in vehicle fuels to 50 ppm or below worldwide, concurrent with clean vehicles and clean vehicle technologies, with roadmaps and timelines developed regionally and nationally". *See* Summary of the Fourth Meeting of the Global Partnership for Clean Fuels and Vehicles, UNEP Headquarters, Nairobi, Kenya, 14-15 December, 2005, available at http://www.unep.org/transport/pcfv/PDF/4GPM-report-final.pdf.

LETTER TO HONORABLE LISA P. JACKSON,
ADMINISTRATOR, ENVIRONMENTAL PROTECTION AGENCY,
FROM MICHAEL J. STANTON, PRESIDENT AND CEO,
ASSOCIATION OF GLOBAL AUTOMAKERS, INC.

GlobalAutomakers

Aston Martin • Ferrari • Honda • Hyundai • Isuzu • Kia • Mahindra • Maserati
McLaren • Mitsubishi • Nissan • Peugeot • Subaru • Suzuki • Toyota

October 21, 2011

The Honorable Lisa P. Jackson
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Dear Administrator Jackson:

The Association of Global Automakers, Inc. (Global Automakers)[1], formerly known as the Association of International Automobile Manufacturers (AIAM), submits this letter in support of reducing further gasoline sulfur content and otherwise improving and harmonizing gasoline quality parameters. Global Automakers represents international motor vehicle manufacturers, original equipment suppliers, and other automotive-related trade associations. Our members' market share of both U.S. sales and production is 40 percent and growing. We work with industry leaders, legislators, regulators, and other stakeholders in the United States to create public policy that improves motor vehicle safety, encourages technological innovation and protects our planet. Our goal is to foster an open and competitive automotive marketplace that encourages investment, job growth, and development of vehicles that can enhance Americans' quality of life.

For the past year we have been working cooperatively with EPA (and even longer with the California Air Resources Board (ARB)) on transitioning to more stringent Tier 3 emissions standards (referred to as LEV III standards in California). To the agencies' credit, EPA and ARB have recognized the benefits of harmonizing the motor vehicle programs for many years, and of course, harmonization between EPA and ARB has been a major and necessary component of the national program for recent rulemakings on greenhouse gas emissions and fuel economy. We appreciate the efforts to date to harmonize such programs and believe that further steps can be taken to ensure the environmental and energy-saving benefits of EPA's regulatory efforts for motor vehicles.

Ten years ago when the current Tier 2/LEV II standards were promulgated, EPA recognized that fuels and vehicles are a system, and that fuel quality standards are an essential element of motor vehicle emissions control along with vehicle standards. In the Tier 2 rulemaking, EPA promulgated the first gasoline sulfur requirements. While this was a needed step, EPA did not harmonize fully with California's stricter and more comprehensive gasoline quality requirements at that time.

[1] For more information, visit www.globalautomakers.org.

GlobalAutomakers

For the Tier 3 rulemaking, it is imperative that EPA focus on setting stringent fuel quality standards to bring U.S. gasoline in parity with fuels in other major world economies and continue the recognition that a system approach – vehicle *and* fuel quality standards – is needed. According to the International Fuel Quality Center's most recent survey[2] (April 2011), the U.S. ranks 46th among countries of the world in gasoline sulfur control, behind the European Union, Japan, and Korea, all of which have a 10 parts per million (ppm) sulfur cap for gasoline. This fuel ranking is despite the fact that U.S. vehicle emissions requirements are among the most stringent, if not the most stringent, in the world and soon to be even more stringent. There is also a disparity between EPA's and ARB's gasoline sulfur content requirements within the U.S., as shown below.

EPA's current gasoline sulfur standards are:

- 30 ppm sulfur average
- 80 ppm sulfur cap at refinery gate
- 95 ppm sulfur cap at the retail pump

ARB's current standards are:

- 15 ppm sulfur average
- 30 ppm sulfur cap (moving to 20 ppm cap in early 2012)

At a minimum EPA should harmonize with ARB's gasoline sulfur requirements in the Tier 3 rulemaking. However, we recommend that both EPA and ARB move to the 10 ppm sulfur cap, which is in place in most of the developed nations. Lower sulfur gasoline will enable automakers to meet more stringent, harmonized Tier 3/LEV III standards. Moreover, it will be instrumental in automakers introducing the advanced technologies needed to comply with the greenhouse gas emissions and fuel economy standards anticipated for the 2017 model year and beyond.

Improving fuel quality also provides a major environmental benefit by improving the catalytic converter operation of vehicles. Gasoline sulfur acts as a "poison" to catalytic converters, the primary emissions control system on vehicles, reducing the effectiveness of the system and resulting in higher emissions than would otherwise occur. This impact will be of particular concern for new Tier 3 vehicles, which will be expected to maintain near zero emission levels for an extended lifetime for the vehicle (out to 150,000 miles).

Reducing the gasoline sulfur content will also provide significant emissions benefits for existing vehicles on the road, or "legacy vehicles." While not all effects from sulfur "poisoning" are reversible, most catalytic converters will partially recover lost effectiveness via the use of lower sulfur gasoline. Thus, the use of lower sulfur gasoline by the legacy fleet will provide significant additional air quality benefits.

Gasoline sulfur content is clearly not the only important gasoline quality parameter. In fact, EPA and ARB have regulated other gasoline parameters in their respective reformulated gasoline (RFG) standards. While ARB applies these RFG standards statewide, EPA does not apply its RFG standards nationwide, leaving many gasoline parameters unregulated except in RFG areas, which represent about 30% of gasoline sold nationwide. In addition to lower sulfur content, EPA should consider the benefits of adopting nationwide standards for other gasoline parameters including aromatics, olefins, and distillation, among others. Global Automakers

[2] See www.ifqc.org/miscellaneouscontent.aspx?contentid=52.

GlobalAutomakers

recommends that EPA consider adoption of the Category 4 unleaded gasoline specifications in the World Wide Fuel Charter.[3]

We would be glad to discuss these recommendations with you. Please feel free to contact John Cabaniss, our Director for Environment & Energy, at (202) 650-5562 or jcabaniss@globalautomakers.org, if you have any questions.

Sincerely,

Michael J. Stanton
President & CEO

cc: Gina McCarthy, Assistant Administrator, OAR
Margo T. Oge, Director, OTAQ
Mary Nichols, ARB
James Goldstene, ARB
Tom Cackette, ARB

[3] See http://www.acea.be/images/uploads/aq/Final%20WWFC%204%20Sep%202006.pdf

LETTERS SUBMITTED TO HONORABLE LISA P. JACKSON, ADMINSTRATOR, ENVIRONMENTAL PROTECTION AGENCY, FROM NESCHAUM, OZONE TRANSPORT COMMISSION, AND NACAA

NESCAUM
www.nescaum.org

Northeast States for Coordinated Air Use Management
89 South Street, Suite 602 Boston, MA 02111
Phone 617-259-2000 Fax 617-742-9162
Arthur N. Marin, Executive Director

March 25, 2011

The Honorable Lisa Jackson
Administrator
U.S. Environmental Protection Agency
Ariel Rios Building
1200 Pennsylvania Avenue NW
Washington, DC 20460

Re: Light-Duty Vehicle Emission Standards

Dear Administrator Jackson:

I am writing on behalf of the environmental agencies in the Northeast to express our strong support for EPA developing a robust federal Tier 3 Light-Duty Vehicle program as soon as possible. The Northeast States for Coordinated Air Use Management (NESCAUM) is an association of the air pollution control programs in Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. Despite significant progress in achieving cleaner air, many states throughout the US face the continuing challenge of attaining and maintaining current and forthcoming national ambient air quality standards.

NESCAUM and our member states are committed to cleaner air and low-emission vehicles, as evidenced by the adoption of the California Low-Emission Vehicle (LEV) program in seven of our member states. While a Tier 3 rule would not directly affect emissions from new vehicles sold in these states, it will improve air quality in the Northeast by reducing pollution transport from neighboring regions and ensuring that out-of-state vehicles operating within our region have comparably low emission characteristics. In addition, to the extent that new federal rules are harmonized with the California program, it will facilitate compliance by automobile manufacturers.

Strong federal emission standards for light-duty vehicles remain among the most important strategies for protecting public health through the reduction of particulate matter (PM), nitrogen oxides (NO_x) and non-methane organic gases (NMOG). Moreover, motor vehicle standards have driven advancements in cost-effective emission control technologies, to the benefit of industry and the public alike. While Tier 2 vehicles are significantly cleaner than their predecessors, there is much more potential to be realized in reducing the adverse effects of motor vehicle pollution on public health and the environment. In addition, projected increases in air emissions resulting from implementation of the federal Renewable Fuels Standard (RFS2) reinforce the need to strengthen emission requirements for light-duty vehicles.

We believe that it is feasible and appropriate to set federal requirements for exhaust and evaporative emissions that are comparably stringent to those proposed by the California Air Resources Board (CARB) in their next low-emission vehicle regulation (LEV III). If changes to fuel specifications are needed to enable manufacturers to meet these more stringent standards, EPA should revise its fuel requirements accordingly. Specifically, we request that EPA address the following issues as part of a Tier 3 program:

- **Exhaust emissions:** Fleet average requirements should be set at levels consistent with CARB's LEV III requirements for NO_x, PM, and NMOG.
- **Evaporative emissions:** Vehicles should be required to achieve evaporative emissions levels consistent with the CARB zero-evaporative emissions standard.

NESCAUM Members:
Connecticut Bureau of Air Management, Anne Gobin
Maine Bureau of Air Quality Control, James Brooks
Massachusetts Bureau of Waste Prevention, Nancy Seidman
New Hampshire Air Resources Division, Robert Scott
New Jersey Division of Air Quality, William O'Sullivan
New York Division of Air Resources, David Shaw
Rhode Island Office of Air Resources, Douglas McVay
Vermont Air Pollution Control Division, Richard Valentinetti

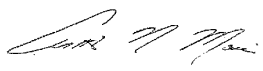
- **Certification fuel:** Given the prevalence of ethanol as a blended component of motor gasoline, and EPA's recent decision to allow gasoline blends of up to 15 percent ethanol by volume, EPA should require the use of a gasoline-ethanol blend in place of indolene as a certification fuel to more accurately reflect emissions from in-use vehicles.
- **Fuel sulfur:** EPA should require an average motor gasoline sulfur concentration of 10 parts per million (ppm). This will enable the use of the most advanced catalysts, thereby facilitating auto manufacturers' efforts to achieve the exhaust emissions levels described above. It will also provide important near-term air quality benefits by improving catalyst performance in the existing vehicle fleet.
- **Fuel volatility:** EPA should set fuel volatility requirements as needed to enable the use of zero-evaporative emissions technology.

Not only will these measures provide critical benefits for ambient air quality and public health, they will also promote economic growth and create jobs throughout the U.S. According to the Manufacturers of Emission Controls Association, the emission control technology industry provides 65,000 domestic jobs and accounted for $12 billion in economic activity in the U.S. in 2010.[1] Moreover, emissions standards have been shown to be very cost effective in terms of public health outcomes. As you are well aware, a recent EPA study[2] found that the health benefits resulting from implementation of the 1990 Clean Air Act Amendments exceed costs by a factor of three to one under the most conservative assumptions; under assumptions considered most likely, benefits exceed costs by a factor of 30 to 1.

In summary, we urge EPA to: (1) move expeditiously to set stringent new standards for exhaust and evaporative emissions from cars and light trucks; (2) revise motor gasoline requirements if needed to facilitate compliance with these new standards; and (3) require the use of a gasoline-ethanol blend in place of indolene as a certification fuel. We believe that new federal standards consistent with the requirements of CARB's LEV III program are achievable and appropriate in the 2022 timeframe. These standards can be met using commercially available technologies, and at a cost that will be recovered many times over through reductions in morbidity and mortality throughout the nation.

We look forward to supporting your work to ensure that the new vehicle standards are strong, achievable, and cost-effective. If you have any questions, please contact me or Matt Solomon of my staff at 617-259-2029 or msolomon@nescaum.org.

Sincerely,



Arthur N. Marin
Executive Director

Cc: Margo Oge, Director, US EPA Office of Transportation and Air Quality
NESCAUM Directors

---

[1] Manufacturers of Emission Controls Association. *MECA Highlights Economic Benefits of Mobile Source Emission Control Industry.* Press release, March 11, 2011. (http://www.meca.org)
[2] U.S. EPA, 2011. *Benefits and Costs of the Clean Air Act: Second Prospective Study – 1990 to 2020.*

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Statement of the OTC Calling on the EPA to Establish Tier 3 Light-Duty Motor Vehicle Fuel and Criteria Pollutant Emissions Standards

The Ozone Transport Commission (OTC) states call on the U.S. Environmental Protection Agency (EPA) to update its requirements regarding the criteria pollutant emissions standards for light-duty motor vehicles. Those requirements were established in 1999 and have not been updated to reflect advances in automotive technologies.

Specifically, a Tier 3 program should be harmonized with the proposed tailpipe, evaporative emissions, and fuel standards in the state of California, which is known as the Low Emission Vehicle (LEVIII) program. A Tier 3 program should also provide emission reductions that go beyond offsetting the emissions increases resulting from the implementation of the Renewable Fuel Standard (RFS2), as deeper reductions are critical to attaining and maintaining the current and anticipated revised ozone health standard. Furthermore, EPA should revise certification procedures to ensure that fuels used in certification are consistent with currently or commonly available motor vehicle fuels

Motor vehicles are significant sources of emissions that lead to the formation of ozone and to toxic air emissions. Recent photochemical screening modeling and highway vehicle emissions calculations using the new Motor Vehicle Emission Simulator (MOVES) model by the OTC and others have demonstrated that additional reductions, particularly for motor vehicle NOx emissions, are critical to attaining and maintaining the current and anticipated revised ozone ambient standard.

There have been significant advances in emission control performance that have occurred since 1999. Tighter standards should be adopted and implemented to reflect these advancements.

In President Obama's May 2010 Presidential Memorandum on Fuel Efficiency Standards for vehicles, the President directed EPA to review the adequacy of current motor vehicle tailpipe standards and update them as necessary.

The OTC states have previously called on EPA to update its requirements regarding the use, installation and purchase of aftermarket catalytic converters.

Given the important role the northeast and mid-Atlantic states have played in the development of the federal motor vehicle emission control program, states in the region are prepared to assist EPA as it develops a proposal for further vehicle emissions controls.

Adopted by the Commission on November 10, 2010



Chair

NACAA
national association of clean air agencies

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June 27, 2011

Lisa P. Jackson
Administrator
U.S. Environmental Protection Agency
Ariel Rios Building
1200 Pennsylvania Avenue, NW
Washington, DC 20004

Dear Administrator Jackson:

We write to you today on behalf of the National Association of Clean Air Agencies (NACAA), the organization of air pollution control agencies in 51 states and territories and over 165 metropolitan areas across the country, to urge timely EPA action to enact a federal "Tier 3" rule putting in place another set of light-duty vehicle (LDV) emissions and gasoline standards to control conventional pollutants.

NACAA worked hard to support EPA's efforts to adopt the Tier 2 vehicle emissions and gasoline sulfur standards that are currently in place and have resulted in substantial, cost-effective emissions reductions. Now, we just as firmly support the agency's efforts to seek additional reductions from LDVs and fuels, which continue to be a dominant source of air pollution in most areas of the country. An appropriately rigorous Tier 3 program based on a systems approach will yield critically needed reductions in nitrogen oxides (NO_x), particulate matter (PM), non-methane organic gases (NMOG), toxic air pollutants and gasoline sulfur, greatly enabling state and local air quality agencies' efforts to achieve and sustain clean air goals and protect public health and welfare. We encourage EPA to work closely with California to ensure that the new federal rules are aligned as much as possible. This will enable automobile manufacturers to meet the new requirements at the lowest possible cost.

EPA assumed a Tier 3 program with strong fuel standards in the baseline analysis for attainment of the health-based National Ambient Air Quality Standards (NAAQS) for ozone adopted in 2008. Add to that the fact that states and localities are now facing, or preparing to face, the challenge of meeting new NAAQS for ozone, PM, nitrogen dioxide and sulfur dioxide. In addition, the ongoing increases in tailpipe emissions that EPA has confirmed will result from the federal renewable fuels standard enacted by Congress in the Energy Independence and Security Act of 2007 further compound the need for the Tier 3 program. Moreover, EPA's most recent National Air Toxics Assessment data show that *every person* in the U.S. has an increased cancer risk of over 10 in one million (one in one million is generally considered "acceptable"); the majority of compounds that cause this risk comes from motor vehicles. In short, unless EPA takes full advantage of the opportunities available for establishing a meaningful and effective Tier 3 program, states and localities across the nation

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will likely be unable to meet their statutory clean air obligations. This also includes states that may adopt California's LEV III program. These states remain extremely vulnerable to transported air pollution from neighboring regions as well as to emissions from out-of-state vehicles that travel within their jurisdictions. The "LEV states" will also derive air quality benefits from Tier 3 in the form of immediate emissions reductions from the existing vehicle fleet and improved in-use performance from LEV III-Tier 3 vehicles as a result of lower gasoline sulfur concentrations.

Accordingly, NACAA recommends that the Tier 3 program include, at a minimum, the following key components:

1) Fleet average tailpipe emissions standards for NO_x, PM and NMOG consistent with those established by CARB in its LEV III programs, as well as more stringent standards for mobile source air toxics;
2) An average gasoline sulfur concentration of 10 parts per million or lower – and a commensurate reduction in the gasoline sulfur cap should be considered in conjunction with this – to expand the scope of technologies that can be used to achieve the envisioned tailpipe standards, improve catalyst performance in existing vehicles and also yield near-term air quality benefits in all areas of the country;
3) Evaporative emissions standards consistent with California's zero-evaporative standard;
4) A new certification fuel that more closely matches real-world fuel by, among other things, including ethanol and accurately reflecting actual retail sulfur levels as well as the removal of methyl tertiary butyl ether; and
5) A fuel volatility standard that will maximize the effectiveness of zero-evaporative-emissions technology.

With respect to timing, NACAA urges that EPA develop and adopt this program on a schedule similar to that which the agency and the U.S. Department of Transportation have announced for the next phase (applicable to model years 2017 to 2025) of motor vehicle greenhouse gas emission standards and fuel efficiency standards: a proposal later this year and final promulgation next year (2012), with an effective date in 2016.

The citizens of our nation are counting on us – state and local air agencies – to provide them with clean, healthful air to breathe, and we are relying on you, Administrator Jackson, and your staff to put forth federal Tier 3 emissions standards and gasoline standards that will ensure the magnitude of reductions necessary from LDVs. We look forward to working with you as you proceed with this extremely important endeavor.

Sincerely,

Nancy L. Seidman (Massachusetts)
Co-Chair
NACAA Mobile Sources and Fuels Committee

Barry R. Wallerstein (Los Angeles, CA)
Co-Chair
NACAA Mobile Sources and Fuels Committee

cc: Gina McCarthy
Margo Oge

SLIDE PRESENTATION FROM MR. DAVID HILBERT,
THERMODYNAMIC DEVELOPMENT ENGINEER, MERCURY MARINE

E15 Outboard Marine High Ethanol Fuel Endurance

A study of the effects of running gasoline with 15% ethanol concentration in current production outboard four-stroke marine engines and conventional two-stroke outboard marine engines.

Prepared By:

David Hilbert

BRUNSWICK
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Overview

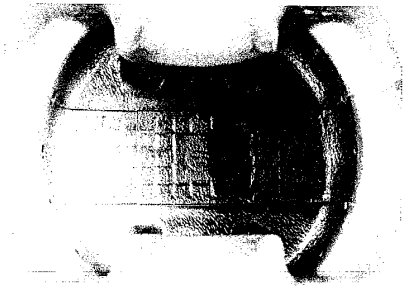
- **Test Objective: Run 300 hours of wide-open throttle (WOT) endurance on 3 engine families.**

  - Two engines from each family: One on E15 (15% ethanol blend fuel) and the other on pure gasoline.
    - 9.9HP 4-stroke carbureted
    - 300HP Supercharged 4-stroke
    - 200HP 2.5L 2-stroke EFI (represents "legacy" product)
    - Engine selection was reviewed and approved by NREL Technical Monitor.

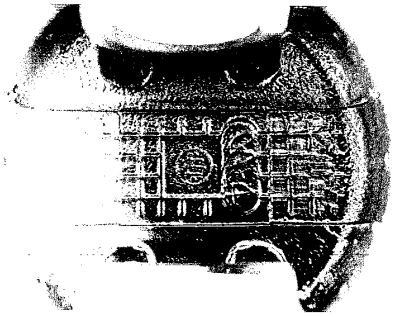
  - Test standards used were common qualification tests.
    - Test regimen was reviewed and approved by NREL Technical Monitor.

9.9HP Carbureted 4-Stroke

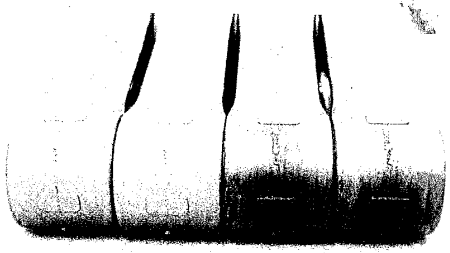
- More carbon deposits on piston underside and rods of E15 engine.



E0



E15

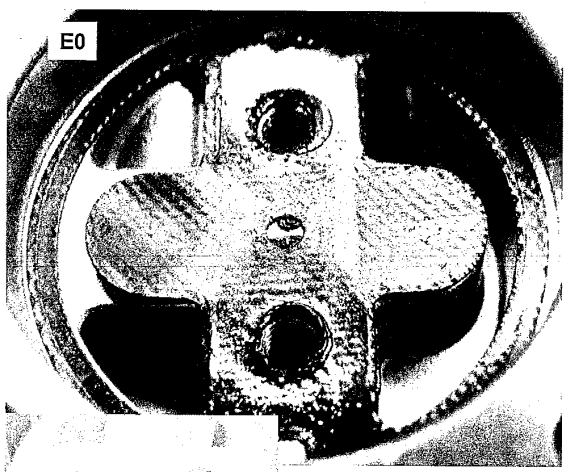


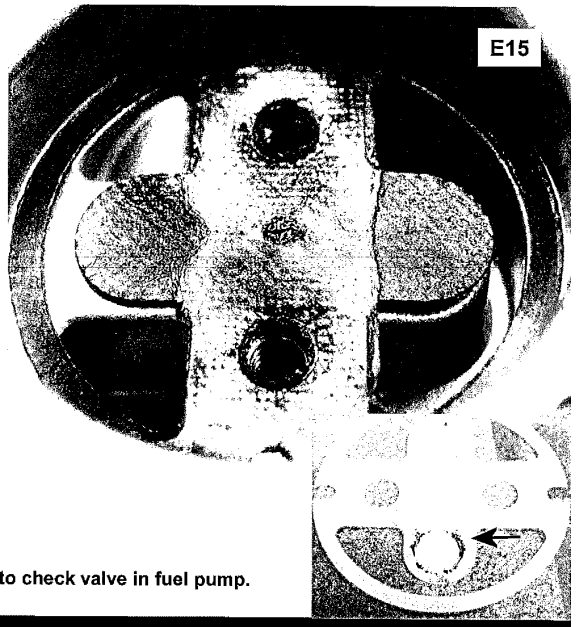
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E-0 E-15

9.9HP Carbureted 4-Stroke

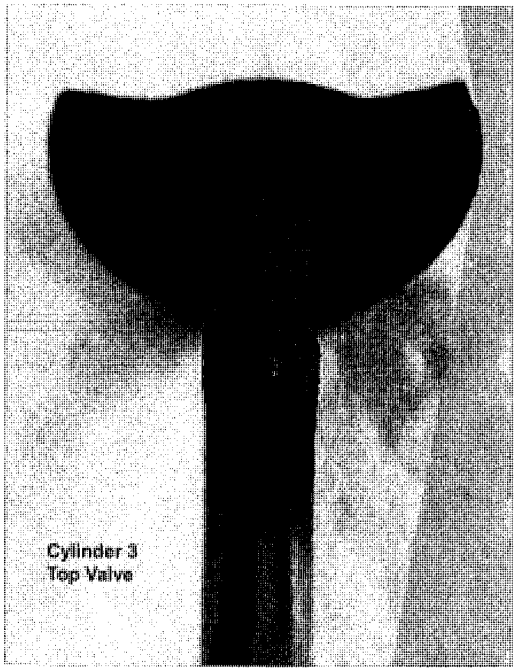
- The fuel pump gasket showed signs of deterioration on the E15 engine compared with the E0 (pure gasoline) engine.

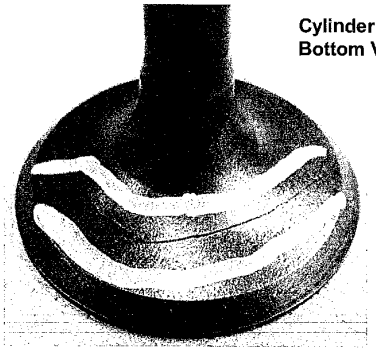


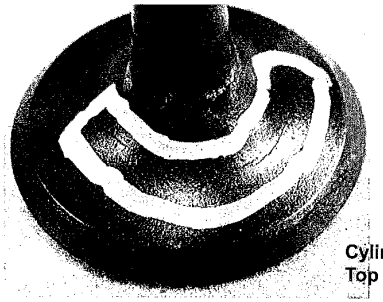


- Material transfer from gasket to check valve in fuel pump.

300HP Supercharged 4-Stroke

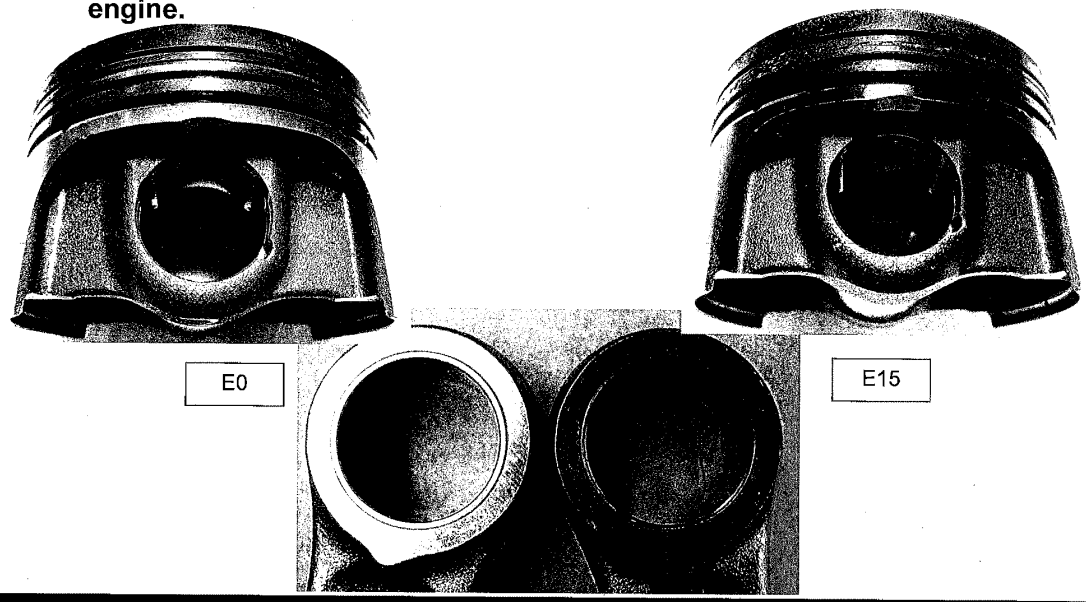






300HP Supercharged 4-Stroke

- **Carbon deposits may indicate that the E15 engine's pistons and connecting rods were hotter during operation than those in the E0 engine.**

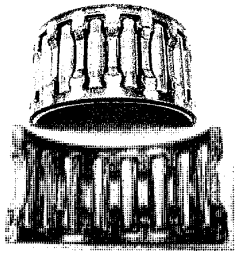


200HP EFI 2.5L 2-Stroke

Recovered Pieces from Failed Rod Bearing

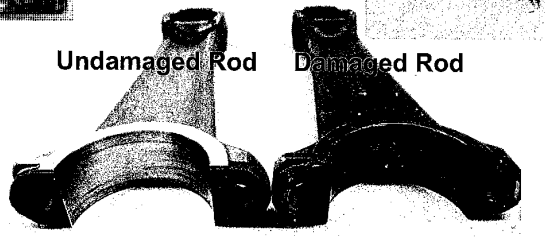


Undamaged Bearing



Undamaged Rod

Damaged Rod



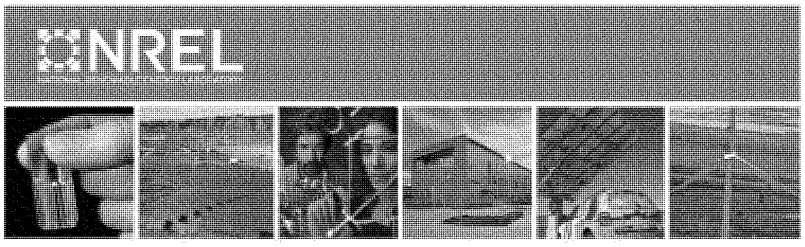
Conclusions and Recommendations Summary

- **Despite the limited scope of the project several significant issues were discovered.**

- **More testing is necessary to understand effects on:**
  - Lubrication system in 2-stroke engines
  - "Driveability"- Examples: cold start and hot restart, acceleration, deceleration, etc.
    - Similar testing by Volvo Penta indicated difficulty starting the E15 engine.[1]
  - Storage (phase separation, corrosion, etc.)

Source 1: M. Cahoon, R. Kolb, and G. Zoubul, *Volvo Penta 4.3 LG E15 Emissions and Durability Test*, NREL SR-5400-52577, October 2011

PRESENTATION FROM MR. DAVID HILBERT,
THERMODYNAMIC DEVELOPMENT ENGINEER, MERCURY MARINE



High Ethanol Fuel Endurance:

A Study of the Effects of Running Gasoline with 15% Ethanol Concentration in Current Production Outboard Four-Stroke Engines and Conventional Two-Stroke Outboard Marine Engines

June 16, 2010 – June 30, 2011

David Hilbert
Mercury Marine
Fond du Lac, Wisconsin

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David Hilbert
Mercury Marine
Fond du Lac, Wisconsin

NREL Technical Monitor: Keith Knoll
Prepared under Subcontract No. NFM-0-40044-01

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High Ethanol Fuel Endurance

A study of the effects of running gasoline with 15% ethanol concentration in current production outboard four-stroke engines and conventional two-stroke outboard marine engines.

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Approved:
Timothy Reid
Director: Engine Design and Development

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Table of Contents

Acknowledgements: 4
Executive Summary 5
Objective: 5
Summary of Results: 5
9.9HP Carbureted Four-Stroke: 5
300HP Four-Stroke Supercharged Verado: 5
200HP EFI 2.5L Two-Stroke: 6
4.3L V6 EFI Four-Stroke Catalyzed Sterndrive: 6
Conclusions and Recommendations: 6
Introduction 7
Project Background: 7
Summary of Marine Engine Considerations: 7
Investigation Details 9
Statement of Problem: 9
Procedure: 9
Test Engine Description: 10
Test Fuel Description: 11
Engine Testing Results 13
9.9HP Four-Stroke: 13
Endurance Test Results 13
Emissions Testing Results 13
Engine Performance Comparison 18
End of Test Teardown and Inspection 22
Verado 300HP Supercharged Four-Stroke: 25
Endurance Test Results 25
Emissions Testing Results 33
Engine Performance Comparison 37
End of Test Teardown and Inspection 40
200 EFI Two-Stroke: 42
Endurance Test Results 42
Emissions Testing Results 43
Engine Performance Comparison 45
End of Test Teardown and Inspection 47
Additional Testing 48
4.3L V6 Catalyzed Sterndrive Emissions Comparison 48
Final Summary 50
Summary of Results: 50
Recommendations: 51
References: 52

List of Tables

Table 1: Test Engine Specifications 11
Table 2: Fuel Analysis Results 11
Table 3: Hardness Measurements on Various 9.9HP Four-Stroke Engine Components 25
Table 4: Verado Exhaust Valve Hardness Measurement Summary 28
Table 5: Hardness Measurements on Various 200HP EFI Two-Stroke Engine Components 47
Table 6: Fuel Flow Comparison on 4.3L V6 Catalyst Sterndrive, EEE vs. E15 49

List of Figures

Figure 1: Power to Weight Comparison, Scatter Band Data Provided by FEV (FEV Motorentechnik GmbH)[1] 8
Figure 2: Example Load Curve Comparison (Automotive data – source 2, boat load data – internal Mercury source) 9
Figure 3: Distillation Curves of Test Fuels 13
Figure 4: 9.9HP Four-Stroke HC+NOx Emissions Results Summary 14
Figure 5: 9.9HP Four-Stroke HC Emissions Results Summary 15
Figure 6: 9.9HP Four-Stroke NOx Emissions Results Summary 15
Figure 7: 9.9HP Four-Stroke CO Emissions Results Summary 16
Figures 8 & 9: Change in Equivalence Ratio vs. Endurance Time-EEE Fuel on E0 engine and E15 Engine 16
Figure 10: Change in Equivalence Ratio vs. Endurance Time-E15 Fuel on E15 Engine 17
Figures 11, 12, and 13: Hydrocarbon Emissions Outputs for Each Emissions Test, E15 Engine on E15 Fuel 18
Figure 14: E0 Engine Power and Torque Output at Endurance Check Intervals 19
Figure 15: E15 Engine Power and Torque Output at Endurance Check Intervals-EEE-E0 Fuel 20
Figure 16: E15 Engine Power and Torque Output at Endurance Check Intervals-E15 Fuel 20
Figure 17: E15 Engine Power and Torque Output, Zero Hour Check-E0-EEE Fuel vs. E15 Fuel 21
Figure 18: E15 Engine-Exhaust Gas Temperature Comparison, Zero Hour Check-E0-EEE Fuel vs. E15 Fuel 22
Figure 19: Piston Undercrown Carbon Deposit Comparison, Cylinder 1, E0 on Left, E15 on Right 23
Figure 20: Small End of Connecting Rod Carbon Deposit Comparison, E0 on Left, E15 on Right 23
Figure 21: Fuel Pump Check Valve Gasket Comparison, E0 on Left, E15 on Right 24
Figure 22: Fuel Pump Check Valve Comparison, E0 on Left, E15 on Right 24
Figure 23: Mineral Deposits in Cooling Jacket, E0 Verado 1B812775A 26
Figure 24: Verado Cylinder Head Indicating Where Head Gasket Failure Occurred, E0 Verado 1B812775A 26
Figure 25: Broken Exhaust Valve from E15 Verado 1B812776, Top Valve in Cylinder 3 27
Figure 26: Cracked Valves from E15 Verado 1B812776, Bottom Valve in Cyl. 3 Left, and Top Valve in Cyl. 6 Right 27
Figure 27: Fatigue Initiation Sites on Cylinder 3 Bottom Exhaust Valve, E15 Verado 1B812776 28
Figure 28: Heat Treatment Test of New Verado Valves 29
Figure 29: Exhaust Valve Failure from Literature Research Showed Similar Failure Mechanism [8] 30
Figure 30: Photo of Section of Cylinder 3, E15 Verado 1B812776, Exhaust Ports on Left 31
Figure 31: Photo of Section of Cylinder 3, E0 Verado 1B812775A, Exhaust Ports on Left 31
Figure 32: Exhaust Valve Lash (Measured Cold) vs. Endurance Time, E0 Substitute Engine 32
Figure 33: Exhaust Valve Lash (Measured Cold) vs. Endurance Time, E15 Engine 33
Figure 34: 300HP Verado HC+NOx Emissions Results Summary 34
Figure 35: 300HP Verado NOx Emissions Results by Mode Point, Representative Zero Hour Test Data 35
Figure 36: 300HP Verado HC Emissions Results by Mode Point, Representative Zero Hour Test Data 36
Figure 37: 300HP Verado CO Emissions Results by Mode Point, Representative Zero Hour Test Data 37
Figure 38: E0 Engine Power and Torque Output at Endurance Check Intervals-EEE-E0 Fuel 38
Figure 39: E15 Engine Power and Torque Output at Endurance Check Intervals-EEE-E0 and E15 Fuel 39
Figure 40: E15 Engine-Exhaust Gas Temperature Change at Wide Open Throttle, EEE-E0 to E15 Fuel 39
Figure 41: Piston Carbon Deposit Comparison, Cylinder 2, E0 on Left, E15 on Right 40
Figure 42: Connecting Rod Carbon Deposit Comparison, Cylinder 2, E0 on Left, E15 on Right 41
Figure 43: Exhaust Cam Lobe Base Circle Detail, Cylinder 3, E0 on Left, E15 on Right 42
Figure 44: 200HP EFI Bearing Failure Pictures 43
Figure 45: 200HP Two-Stroke HC+NOx Emission Results Summary 44
Figure 46: 200HP Two-Stroke CO Emission Results Summary 44
Figure 47: E0 Engine Power and Torque Output at Endurance Check Intervals-EEE-E0 Fuel 45
Figure 48: E15 Engine Power and Torque Output at Endurance Check Intervals-EEE-E0 and E15 Fuel 46
Figure 49: E15 Engine-Exhaust Gas Temperature Change at Wide Open Throttle, EEE-E0 to E15 Fuel 46
Figure 50: Cylinder 2 Wrist Pin Comparison, E0 on Left, E15 on Right 47
Figure 51: Emissions Comparison 4.3L V6 Catalyst Sterndrive, EEE vs. E15 49

Acknowledgements

This report and the work described herein were funded by the American Reinvestment and Recovery Act (ARRA) under stewardship of the Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE) Vehicle Technologies Program. The technical direction of Kevin Stork (Fuels Technology Team Lead) and Steve Przesmitzki is gratefully acknowledged.

The National Renewable Energy Laboratory (NREL) provided Mercury with the opportunity to perform the work. Keith Knoll was excellent to work with as the Technical Monitor and is given thanks for the collaboration, technical guidance, and most importantly, patience.

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Executive Summary

Objective:

The objective of this work was to understand the effects of running a 15% ethanol blend on outboard marine engines during 300 hours of wide-open throttle (WOT) endurance – a typical outboard marine engine durability test. For the three engine families evaluated, one test engine each was endurance tested on E15 fuel with emissions tests conducted on both E0 and E15 fuel, while a second control engine was emissions and endurance tested on E0 fuel for each engine family.

Summary of Results:

Results are based on a sample population of one engine per test fuel. As such, these results are not considered statistically significant, but may serve as an indicator of potential issues. More testing would be required to better understand the potential effects of E15.

9.9HP Carbureted Four-Stroke:

- The E15 engine exhibited variability of HC emissions at idle during end-of-endurance emissions tests, which was likely caused by lean misfire.
    - Both the E0 control engine and E15 test engine ran leaner at idle and low speed operation at the end of endurance testing compared with operation at the start of the test.
    - The trend of running lean at idle coupled with the additional enleanment from the E15 fuel caused the E15 engine to have poor run quality (intermittent misfire or partial combustion events) when operated on E15 fuel after 300 hours of endurance.
    - CO emissions were reduced when using E15 fuel due to the leaner operation, as expected for this open-loop controlled engine.
- The E15 engine exhibited reduced hardness on piston surfaces based on post-test teardown analysis.
    - The exhaust gas temperature increased 17°C at wide open throttle as a result of the leaner operation when using E15 fuel. Higher combustion temperatures may have caused observed piston hardness reductions. Lack of pre-test hardness measurements prevented a conclusive assessment.
- Several elastomeric components on the E15 engine showed signs of deterioration compared with the E0 engine.
    - Affected components were exposed to E15 fuel for approximately 2 months; signs of deterioration were evident.

300HP Four-Stroke Supercharged Verado:

- The E15 engine failed 3 exhaust valves close to the end of the endurance test.
    - Metallurgical analysis showed that the valves developed high cycle fatigue cracks due excessive metal temperatures.
- The pistons on the E15 engine showed indications of higher operating temperatures compared to the E0 engine's pistons as evidenced by the visual difference in carbon deposits.
- The E15 engine generated HC+NOx values in excess of the Family Emissions Limit (FEL) when operated on E15 fuel, but did not exceed that limit when operated on E0 emissions certification fuel.

- The primary contributor to this increase in exhaust emissions was NOx due to enleanment caused by the oxygenated fuel.
- CO emissions were reduced when using E15 fuel due to leaner operation, as expected for this open-loop controlled engine.

200HP EFI 2.5L Two-Stroke:

- The 200 EFI two-stroke engine showed no signs of exhaust emissions deterioration differences due to the fuel.
  - The E15 fuel caused the engine to run lean resulting in reduced HC and CO emissions. NOx was of little concern on this type of engine since NOx accounted for less than 2% of the total regulated HC+NOx emissions.
- The E15 engine failed a rod bearing at 256 hours of endurance, which prevented completion of the 300 hour durability test.
  - Root cause of the bearing failure was not determined due to progressive damage.
  - More testing would be necessary to understand the effect of ethanol on oil dispersion and lubrication in two-stroke engines where the fuel and oil move through the crankcase together.

4.3L V6 EFI Four-Stroke Catalyzed Sterndrive:

- Since E15 fuel was readily available in the test facility and an engine equipped with exhaust catalysts was on the dynamometer, emissions tests were conducted on a 4.3L V6 sterndrive engine to better understand the immediate impacts of ethanol on this engine family.
  - At rated speed and load (open-loop fuel control) E15 caused exhaust gas temperatures to increase by 20°C on average and the catalyst temperatures to increase by about 30°C.
  - More rapid aging of the catalyst system occur due to the elevated catalyst temperature when considering the high load duty cycle typically experienced by marine engine applications.

Conclusions and Recommendations:

Several issues were discovered in this study from an exhaust emissions and an engine durability standpoint as a result of running E15 fuel in outboard marine engines. Run quality concerns were also identified as a result of the lean operation on the carbureted engine.

Additional investigation is necessary to more fully understand the observed effects and to extrapolate them to all types of marine engines over broader operating conditions. Effects on operation at part load, transient acceleration/deceleration, cold start, hot restart, and other driveability-related concerns need to be evaluated. This test program was mainly testing for end-of-life durability failures, which would not likely be the first issues experienced by the end users. A customer would likely be affected by run quality/driveability issues or materials compatibility/corrosion issues before durability issues. The wide range of technology used in marine engines due to the wide range of engine output will complicate this issue (Mercury Marine produces engines from 2.5HP-1350HP).

More testing is needed to understand how ethanol blends affect lubrication systems in two-stroke engines that have fuel and oil moving through the crankcase together. Crankcase oil dispersion is the only mechanism by which two-stroke engines of this architecture provide lubrication at critical interfaces such as bearings and cylinder walls. Ethanol may have an effect on the dispersion or lubricity of the oil.

A better understanding of how long term storage affects ethanol blends in marine fuel systems would require more real-world testing. Marine vessels often go through long periods of storage that could affect the fuel systems given the fact that the ethanol portion can absorb water when exposed, especially in humid areas near saltwater.

Introduction

Project Background:

This project was a cooperative effort to assess the feasibility for marine engines of increasing the allowable ethanol concentration in gasoline above the current legal limit of 10%. Specifically, a 15% ethanol / 85% gasoline fuel blend (E15) was tested in current production and legacy outboard marine engines. Gaseous exhaust emissions and engine durability were assessed on a typical durability test cycle. Three separate engine families were evaluated. A 200HP EFI two-stroke engine was chosen to represent legacy product. A 9.9HP carbureted four-stroke engine and a 300HP supercharged EFI four-stroke engine represented current product. Two engines were tested from each family. One was operated on E15 fuel and the other was operated on E0 gasoline. Emissions data from each engine were obtained before, in the middle of, and after durability testing.

Summary of Marine Engine Considerations:

Marine engines require unique considerations when altering the fuel supplied to operate the engine. Considering these engines are frequently used in remote locations (offshore fishing for example), it is critical to ensure that the fuel does not cause or contribute to an engine malfunction. Changes in fuel formulations and the resulting effects on marine engine operability are of high importance.

Outboard marine engines span a large range of rated power output and technology which yields significant complexity when trying to understand the effects of changing the fuel supplied to the engine. When all of the typical Mercury production engines and the Mercury Racing products are included (inboards and outboards), engines from 86cc, 2.5HP up to 9.1L 1350HP twin turbo configurations are produced. Mercury outboards (the focus of this study) range in output and design from the 2.5HP splash lubricated carbureted four-stroke engines to 350HP supercharged EFI four-stroke and 300HP direct fuel injected two-stroke engines. If sterndrive/inboard engines are considered, the technology list gets even broader. The non-racing sterndrive products range from 135HP carbureted 4 stroke to 430HP closed-loop catalyzed EFI 4 stroke with onboard diagnostics. The sales volumes of marine engines may be much smaller than automotive or small offroad utility engines, but the range of power (nearly 3 orders of magnitude) and the range of available technology of marine engines is much wider than these other categories individually.

The marine application requires an engine that has high power density and remains durable at high speeds and loads. It is important to minimize the amount of weight added to the vessel from the powertrain to maximize the payload and minimize drag. Boat hull drag is considerable at typical boat operating speeds resulting in high engine speeds and loads for extended periods. The result of these factors leads to engines which are high performance and made from premium materials. Changing the fuel specification must be carefully considered to assure that durability is not sacrificed. Figure 1 illustrates the power density of the Verado engine (the 300HP supercharged EFI engine family used in this study) compared to automotive engines that were contemporary when the Verado engine was introduced for the 2005 model year. Figure 2 shows a relative comparison of the vehicle load curves of a boat with a planing hull to an automobile. The likelihood of experiencing problems as a result of extended operation at or near WOT are far more pronounced on a marine engine than an automotive engine due to the great difference in vehicle load curves.

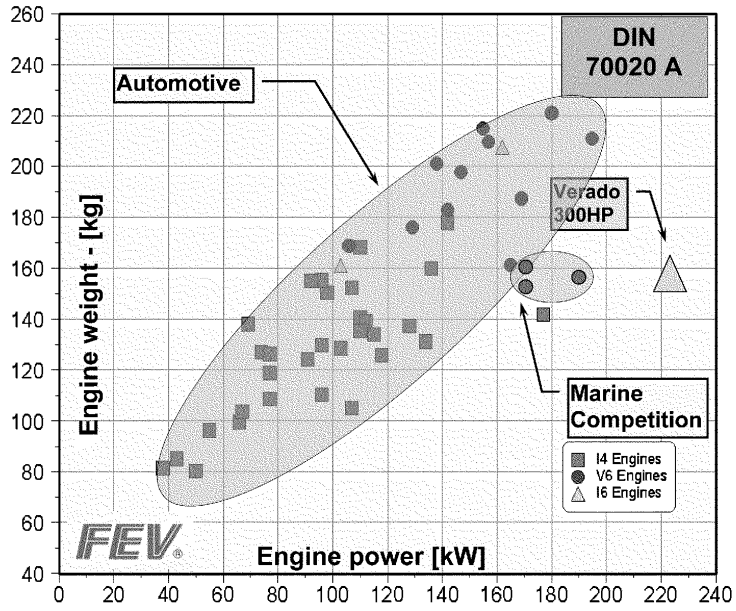


Figure 1: Power to Weight Comparison, Scatter Band Data Provided by FEV (FEV Motorentechnik GmbH)[1]

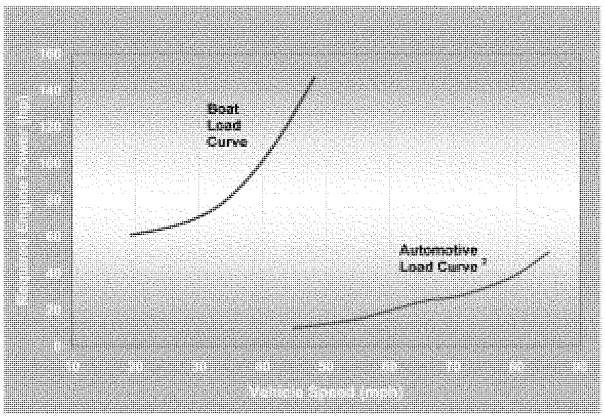


Figure 2: Example Load Curve Comparison (Automotive data – source 2, boat load data – internal Mercury source)

Investigation Details

Statement of Problem:

Procedure:

The engine testing process began by preparing each engine. This included instrumentation of the test engines as well as performing some basic checks (varied by engine type). The instrumentation process included installation of an exhaust emissions probe that met the requirements of the EPA 40 CFR Part 91 regulations.

Each engine was rigged onto an appropriate dynamometer and a break-in process was performed. The break-in consisted of increasing speed and load settings for approximately 2.5 hours total duration and was performed on E0 gasoline for all engines. This was followed by a power run to determine the wide open throttle (WOT) performance of each engine. The power run was performed on E0 gasoline on all engines and also on E15 fuel for only the E15 test engines. The power run included speed points from 2000RPM up to the maximum rated speed of the engine.

Once the WOT performance was checked, emissions testing was performed using reference-grade E0 gasoline (EEE fuel: EPA Tier II emissions reference grade fuel). The emissions tests were done in triplicate to check repeatability and were run in accordance with the EPA requirements set forth in 40 CFR Part 91. Emissions tests were also performed on the E15 engines in triplicate using the E15 test fuel. Although this E15 test fuel was not blended from the reference-grade E0 gasoline, these tests provide some comparison of exhaust emissions between E0 and E15 while minimizing engine-to-engine variability.

Following the above emissions checks, each engine was prepared for the durability testing. This included doing a basic visual inspection as well as some general engine power cylinder integrity checks (example: compression test and cylinder leak-down). These integrity checks were also repeated at the durability mid-point and end-of-life test point as well.

The first half of the durability test was then performed. Each engine was rigged in Mercury's Indoor Test Center, which consisted of large endurance test tanks, air supply systems, and data acquisition systems. Each engine was fitted with the appropriate propeller to operate the engine approximately in the midpoint of the rated speed range at wide open

throttle. The engine instrumentation was continuously monitored and the data was recorded for the duration of the endurance test. Operational shutdown limits were placed on critical channels (min/max engine speed, max coolant temperature, etc) to monitor the health of the engine for the entire durability test period. Periodic maintenance was performed on each engine (as appropriate for the engine type: oil level checks and changes, accessory drive belts, etc). This maintenance was performed in an accelerated manner as compared with typical customer maintenance intervals since the durability testing causes accelerated wear as compared with typical customer use. These protocols are typical of those used by Mercury for any durability test.

Once the first half of the durability testing was completed, each engine was rigged on the dynamometer again. Emissions tests on the appropriate fuel(s) were performed according to the procedures described above. The tests were again performed in triplicate to be able to evaluate repeatability. Each engine also got a visual inspection and the general engine power cylinder integrity checks before being returned to durability testing.

After the midpoint emissions testing was completed, each engine was returned to the Indoor Test Center endurance tank to complete the second half of the durability testing. The testing was performed in the same manner as the first half of the durability portion.

When the durability testing was complete, each engine was returned to the dynamometer for post-durability emissions tests on the appropriate fuel(s). A post-endurance WOT performance power run was also performed to compare with the pre-durability power run.

Finally, after all running-engine tests were completed, each test engine underwent a complete tear-down/disassembly and inspection. This inspection included checks and measurements to assess the degree of wear, corrosion issues, cracks, etc. on power cylinder components. Emphasis was placed on components that would be at risk due to the differences in the fuels (exhaust valves due to exhaust gas temperature differences, for example).

Test Engine Description:

The engines used for this testing were all built as new engines on the production line and were randomly selected. They were not specially built or hand-picked. The choice of engine families to include in this program was based on representing a wide range of technology, a wide range of power output, and a significant annual production volume. The final engine family selection was approved by the Technical Monitor at NREL. Two 4-stroke engine families were selected to represent current production engines. A two-stroke engine family was selected to represent "legacy" products. Table 1 summarizes each test engine configuration.

The 9.9HP four-stroke engine is used on a wide range of applications from small fishing boats, inflatable boats, and as a "kicker" engine. A "kicker" engine is an auxiliary engine used for low speed boat maneuvering while fishing on a large boat which includes a larger engine (150+HP) for the main propulsion. The 9.9HP engine is considered a portable engine. It was selected for this testing due to high sales volume and the fact that it represents the typical architecture for many of Mercury's small carbureted four-stroke offerings. It should be noted that the settings for the carburetors on both of the 9.9HP test engines were set and sealed at the carburetor manufacturer. They were not tampered with by any Mercury personnel and were run just as they would if they were used by the end customer. The only adjustment allowed was the idle throttle stop to set the idle speed, which is the only adjustment a customer has access to.

The Verado engine is considered the "flagship" outboard product at Mercury Marine. The non-Racing version used in this study is available in power outputs ranging from 200-300HP. These engines are used on boats with single, dual, triple, and even quad engine installations ranging from multi-engine offshore fishing boats & US Coast Guard patrol boats, high speed bass boats, all the way to commercial fishing vessels and ferry boats. The supercharged 300HP Verado was selected for testing due to the high performance nature of its design and the demands of this market segment. The Verado engines had an open loop electronic fuel injection system with no user adjustment possible.

The 200HP EFI two-stroke engine represents the "legacy" two-stroke products. The 2.5L platform has been the basis for carbureted, crankcase fuel injected (which is the case for the test engines used), and direct cylinder injection models. The platform has roots that can be traced back to the 1970's. This engine was selected for testing because of the large number of engines that have been built off of this platform over the last several decades and that it represents the typical architecture for a variety of Mercury's two-stroke product. An engine configuration with an EFI fuel system was selected to improve consistency in testing. The 2.5L 200HP EFI engine had an open loop electronic fuel injection system with no user adjustment possible.

Table 1: Test Engine Specifications

Engine Family	9.9HP Four-Stroke	Verado	200HP EFI
Gas Exchange Process	Four-Stroke	Four-Stroke	Two-Stroke
Power Rating at Prop	9.9HP	300HP	200HP
Cylinder Configuration	Inline 2 Cylinder	Inline 6 Cylinder	60 Degree V-6 Cylinder
Displacement	0.209 Liter	2.59 Liter	2.51 Liter
Fuel Induction System	Single Carburetor w/Accelerator Circuit, 2 Valve per Cylinder, Single Overhead Cam	Supercharged Electronic Fuel Injected 4 Valve per Cylinder, Dual Overhead Cam, Electronic Boost Control, Electronic Knock Abatement Strategy	Electronic Fuel Injected with Oil Injection, Loop Scavenged Porting, Crankcase Reed Induction, Electronic Knock Abatement Strategy
Dry Weight	108 lbs / 49 kg	635 lbs / 288 kg	425 lbs / 193 kg
Fuel Octane Requirement	87 Octane R+M/2 Minimum Required	92 Octane R+M/2 Recommended, 87 Octane R+M/2 Minimum Required	87 Octane R+M/2 Minimum Required

Test Fuel Description:

The fuels used in the endurance testing were intended to be representative of typical pump-grade fuels that could be commonly available to the general consumer. The primary factors in sourcing the E15 test fuel were consistency of fuel properties for the duration of testing, consistency of ethanol content at 15%, octane performance that met specific requirements for each test engine, and a representative distillation curve to match charge preparation characteristics. The E15 test fuel was splash blended by our fuel supplier in one batch to ensure consistency throughout testing. The E0 and E15 endurance fuels were sourced from different suppliers; as such there were likely differences in the additive packages (including the concentration of additives) of the fuels. Since the primary duty cycle was wide open throttle endurance, the additive package differences likely had little influence on the test. Since the Verado engine had a premium fuel recommendation, the E15 fuel was blended at a target of 91 octane [R+M]/2. The blend stock used was a typical pump-grade fuel that the supplier used for retail distribution. The E0 fuels used for the endurance testing were also typical pump-grade fuels that the fuel supplier had available for distribution. Both a Regular (87 octane [R+M]/2) and a Premium (91 octane [R+M]/2) fuel supply were maintained at Mercury for testing on this program and all other internal Mercury test programs. The emissions tests on E0 fuel were all performed using EPA Tier II EEE fuel sourced from specialty fuel manufacturer Johann Haltermann Ltd.

Samples of several of the test fuels were sent to outside laboratories for analysis. The parameters that were considered were: the distillation curve (ASTM D86)[3], Research and Motor Octane (ASTM D2699[4] and D2700[5]), density, and API gravity. In addition, NREL measured ethanol content via the Grabner IROX 2000 Gasoline Analyzer and ASTM D5501[6] for the E15 fuel. The Grabner IROX 2000 measures ethanol via infrared spectroscopy (per ASTM 5845[7]) and is valid in the range of 0 – 25% ethanol. The ASTM 5501[6] method uses gas chromatography and is only valid for high levels of ethanol (93% to 97% ethanol); it was used here only as a reference. In-house fuel samples were also taken and analyzed on the Petrospec GS-1000 analyzer. This analyzer was used to estimate the octane and measure the oxygenate concentration. Like NREL's Grabner IROX 2000, the Petrospec GS-1000 operates on the infrared spectroscopy concept and determines the ethanol concentration (up to 15%) per ASTM D5845[7]. The results from the Petrospec machine were used as reference values only, primarily for quality control.

Table 2 shows the various measurements made on the test fuels from the different measurement laboratories. The majority of the parameters were within expected ranges for the tolerance of the measurements used. The ASTM D5501[6] procedure used at NREL showed that the ethanol concentration was 18%. The results from the 2 infrared

spectroscopy measurements from both NREL and Mercury showed concentrations of approximately 14%. The results from the 2 methods bracket the target concentration of 15%, which was the actual concentration that the fuel was blended to at the fuel supplier. Only one sample of E15 was analyzed, which was valid since all of the E15 fuel was blended in one batch. The data sets from the 87 octane bulk/pump fuel and the 91 octane bulk/pump fuel used on endurance, and the data from the EEE were from one load of fuel of the multiple loads of fuel of each type used during the duration of the testing.

Table 2: Fuel Analysis Results

Fuel Analysis		E15 Fuel	EEE	87 Bulk Fuel	91 Bulk Fuel	91 Bulk Fuel Repeat
Sample Date		**10/21/2010**	**10/8/2010**	**10/15/2010**	**10/15/2010**	**2/10/2011**
Fuel Analysis Performed at Outside Laboratory						
Research Octane (ASTM D2699)	RON	95.7	97.2	89.6		93.4
Motor Octane (ASTM D2700)	MON	86.3	88.5	84.6		87.5
[R+M]/2	AKI	91.0	92.9	87.1		90.45
Density @ 15.5C	kg/L	0.752	0.744			
API Gravity	°API	56.5	58.7			
Fuel Analysis Performed at NREL						
Ethanol Content (ASTM D5501)	%	18+/-1%				
Ethanol Content (IROX analyzer)	%	14%				
Fuel Analysis Performed at Mercury Marine						
Petrospec analyzer (E15 data ave. of 2 samples)						
Ethanol Content	%	14.1%	0	0	0	
RON	RON	95.7	95.8	89.4	92.9	
MON	MON	84.7	87.7	83.3	87.2	
[R+M]/2	AKI	90.2	91.7	86.4	90.1	
Reid Vapor Pressure (Mercury analysis)	PSI	8.5	9.0	10.8	10.7	

The distillation curves for the various test fuels were also measured. The results can be seen in Figure 3 below. The data shown in Figure 3 were from the actual test fuels used in this testing. The distillation curve from the E15 fuel showed a large step change in the region of the boiling point of ethanol, as was expected.

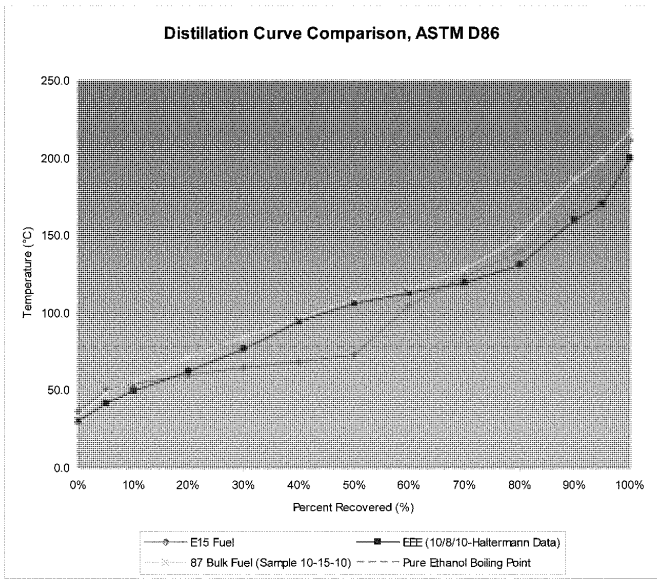


Figure 3: Distillation Curves of Test Fuels

Engine Testing Results

9.9HP Four-Stroke:

Endurance Test Results

The endurance testing on the 9.9HP engine family precipitated no significant failures. There were no incidents related to the test fuels reported on either engine. There were several parameters measured at the start, middle, and end of test to check the general health of the engine during the course of the endurance test. These included cranking compression, power cylinder leakdown, cam timing, and valve lash. All of these parameters remained relatively unchanged through the course of testing within the repeatability of the measurement techniques used. Several fuel-effect differences between the test engines, however, were discovered during the end of test teardown and inspection. These differences are summarized in the section below.

Emissions Testing Results

A summary of the emissions results are shown in Figure 4 below, with the 5 mode total weighted specific HC+NOx values plotted on the Y axis and the amount of endurance time on each engine plotted on the X axis. Each data point on the curve represents the average emissions value of the 3 emissions tests performed at each interval. The error bars represent the minimum and maximum values of the 3 emissions tests at each interval. The dashed yellow line shows

the data from the E0 engine (serial number 0R364814). The solid red and blue lines show the emissions data from the E15 engine (serial number 0R352904) using E15 and E0 (EEE) fuels, respectively. Figure 4 shows that the E0 engine had significantly lower emissions than the E15 engine when run on the same fuel. After reviewing the history of the emissions audits on this engine family dating back to its introduction in 2005, both of these engines were within normal production variability.

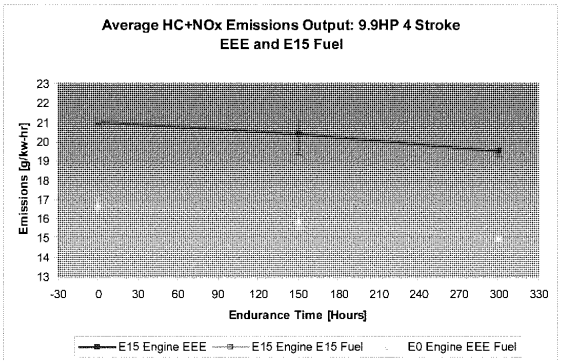


Figure 4: 9.9HP Four-Stroke HC+NOx Emissions Results Summary

In order to better understand the emissions output, the HC, NOx, and CO constituents were broken out and plotted separately in Figures 5, 6, and 7 respectively. The values for each constituent are the five mode totals of each.

Figures 5 and 6 show that the HC emissions predominantly defined the overall trends and variability in the total HC+NOx trends seen in Figure 4. The NOx data shown in Figure 6 had low test-to-test variability and the values were relatively flat (perhaps slightly declining for the E15 engine on E15 fuel) over the life of both engines.

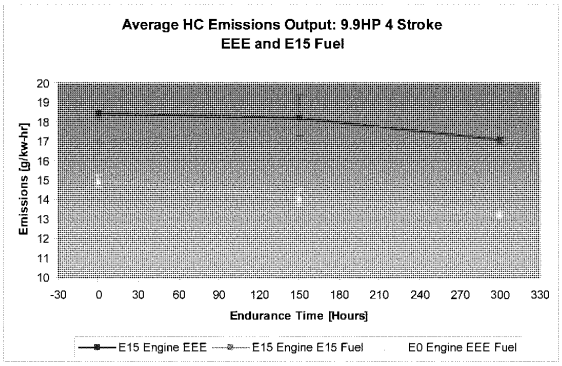


Figure 5: 9.9HP Four-Stroke HC Emissions Results Summary

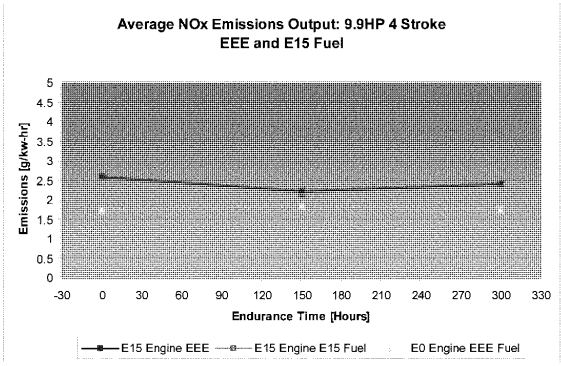


Figure 6: 9.9HP Four-Stroke NOx Emissions Results Summary

There was a general downward trend in CO over endurance time for the E15 engine on both fuels. The E0 showed some reduction in CO between 0 and 150 hours and remained relatively flat from 150 to 300 hours. The reduction in CO would suggest that the engines were running leaner since the primary driver for changing the CO emissions is typically the equivalence ratio.

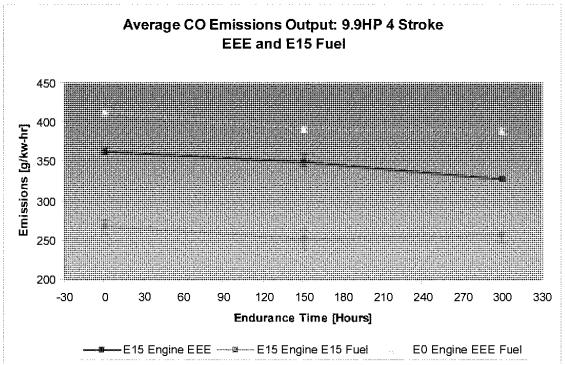
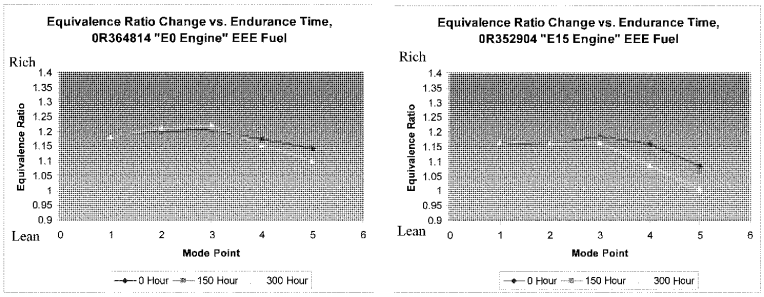


Figure 7: 9.9HP Four-Stroke CO Emissions Results Summary

The enleanment over time trend predicted from the CO data in Figure 7 was confirmed in Figures 8 and 9 for both the E0 and E15 engines operated on EEE-E0 fuel in both cases. The interesting thing to note was that the primary modes that became leaner were modes 4 and 5. During the end of test inspection on both engines, wear on the throttle plates was found on the sides where the throttle shafts went through the carburetor bodies. The wear caused gaps around the throttle plates which allowed excess air to enter the engines at low throttle opening positions (high manifold vacuum), which included Modes 4 and 5. The amount of wear found was considered normal for the amount of endurance time the engines experienced and was found on both engines.

It should be noted that the E15 engine ran leaner than the E0 engine when operated on EEE-E0 fuel, as can be seen in Figures 8 and 9 from a comparison of the "0 hour" equivalence ratios of both engines. This difference in equivalence ratio is considered to be in the normal production variability of this carbureted engine family.



Figures 8 & 9: Change in Equivalence Ratio vs. Endurance Time-EEE Fuel on E0 engine and E15 Engine

In addition, the equivalence ratio vs. endurance time data was plotted for the E15 engine when operated with E15 fuel in Figure 10. The graph shows the same trend of leaner operation vs. endurance time for Modes 4 and 5, as expected. However, when looking at the equivalence ratio values generated by the engine at Mode 5, it is clear that the engine ran very lean after 300 hours of endurance. This lean operation was the result of the inherent enleanment from the E15 fuel coupled with the trend of the engine to operate leaner with more endurance time due to the throttle plate wear.

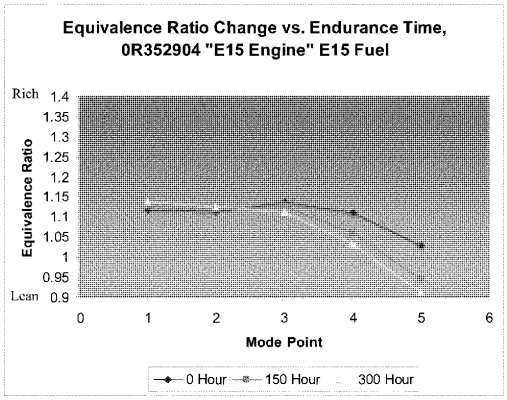
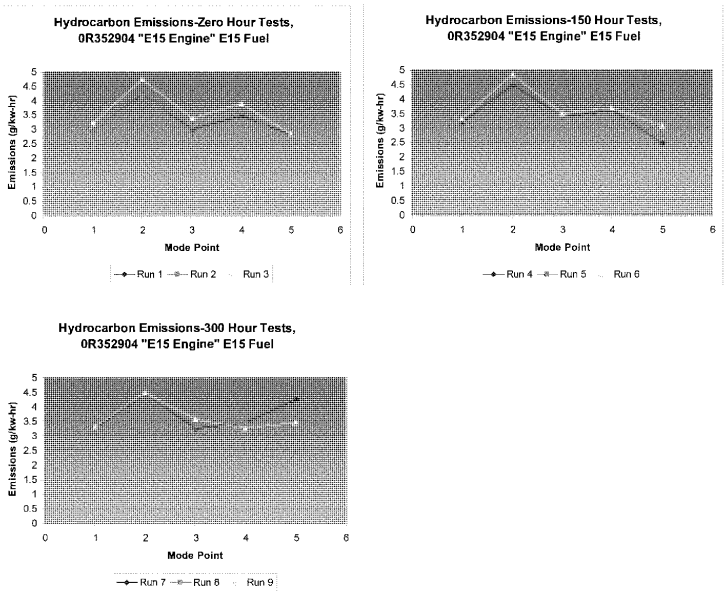


Figure 10: Change in Equivalence Ratio vs. Endurance Time-E15 Fuel on E15 Engine

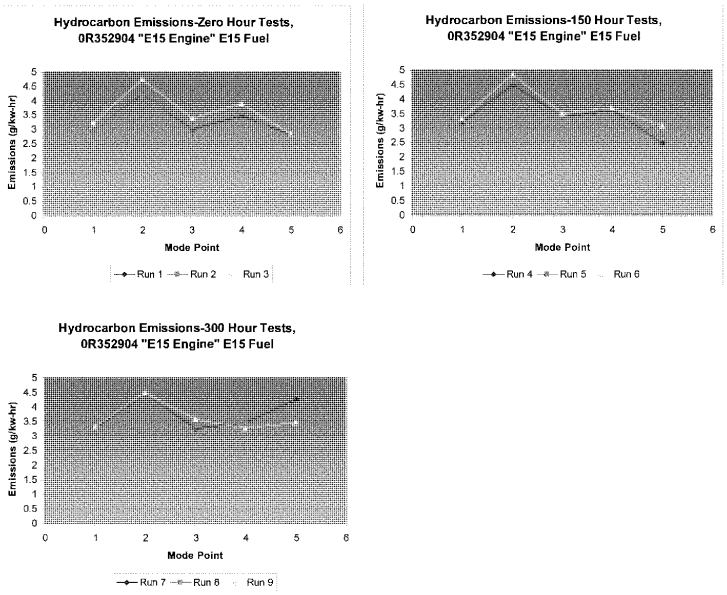
It is clear that both engines ran leaner with more endurance time, yet the HC emissions increased (on average) for the E15 engine using E15 fuel (see Figure 5). To get more understanding, the hydrocarbon emissions results from each individual emissions test were plotted out in Figures 11-13 for the E15 tests at 0, 150, and 300 hours of endurance, respectively. The difference in HC at the 300 hour emissions check was caused by the Mode 5 (idle) point as Figure 13 shows. The high variability of HC emissions at Mode 5 may have been caused by poor run quality leading to intermittent misfire as the equivalence ratio trended further lean of stoichiometric (<0.925) with increasing run time.



Figures 11, 12, and 13: Hydrocarbon Emissions Outputs for Each Emissions Test, E15 Engine on E15 Fuel

Engine Performance Comparison

The power and torque data from the E0 9.9HP engine is shown in Figure 14 below. [Note: All power and torque curves were normalized to a set torque and power to make consistent comparisons possible across different engines, fuels, and amount of endurance time. The highest power and torque values generated on any of the tests were used as the reference power and torque setting and the runs were normalized back to these values.] There was a clear trend of increasing power and torque with more endurance time on the E0 engine. There was an increase of 3.2% in peak power and a 2.1% increase in peak torque when comparing the zero hour test with the 300 hour test. Similar graphs for the E15 engine are shown in Figure 15 on the E0-EEE fuel and in Figure 16 on the E15 fuel. Figures 15 and 16 show that there was generally a trend of decreasing power and/or torque with more endurance time on the E15 engine. On the E0-EEE fuel there was no change in peak power, but a loss of 1% peak torque when comparing the zero hour test with the 300 hour test on the E15 engine. Results on E15 fuel were similar, with a loss of peak power of 0.9% and a loss of peak torque of 2.1% when comparing the zero hour test with the 300 hour test. The mechanism that caused the E0 engine to have increasing power vs. endurance time and the E15 engine to have decreasing power vs. endurance time is unclear.



Figures 11, 12, and 13: Hydrocarbon Emissions Outputs for Each Emissions Test, E15 Engine on E15 Fuel

Engine Performance Comparison

The power and torque data from the E0 9.9HP engine is shown in Figure 14 below. [Note: All power and torque curves were normalized to a set torque and power to make consistent comparisons possible across different engines, fuels, and amount of endurance time. The highest power and torque values generated on any of the tests were used as the reference power and torque setting and the runs were normalized back to these values.] There was a clear trend of increasing power and torque with more endurance time on the E0 engine. There was an increase of 3.2% in peak power and a 2.1% increase in peak torque when comparing the zero hour test with the 300 hour test. Similar graphs for the E15 engine are shown in Figure 15 on the E0-EEE fuel and in Figure 16 on the E15 fuel. Figures 15 and 16 show that there was generally a trend of decreasing power and/or torque with more endurance time on the E15 engine. On the E0-EEE fuel there was no change in peak power, but a loss of 1% peak torque when comparing the zero hour test with the 300 hour test on the E15 engine. Results on E15 fuel were similar, with a loss of peak power of 0.9% and a loss of peak torque of 2.1% when comparing the zero hour test with the 300 hour test. The mechanism that caused the E0 engine to have increasing power vs. endurance time and the E15 engine to have decreasing power vs. endurance time is unclear.

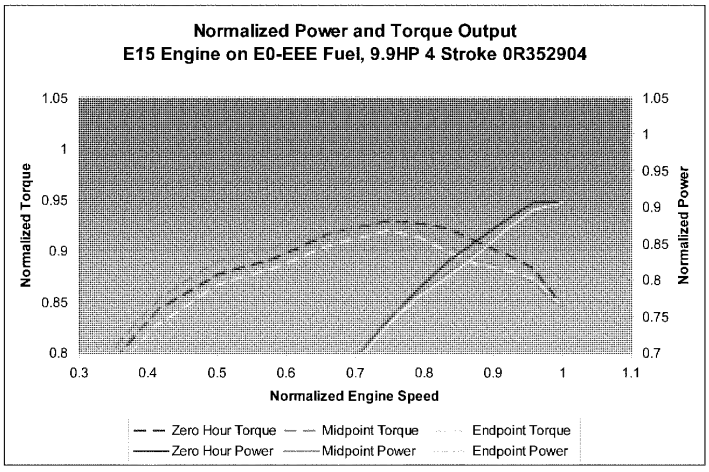


Figure 15: E15 Engine Power and Torque Output at Endurance Check Intervals-EEE-E0 Fuel

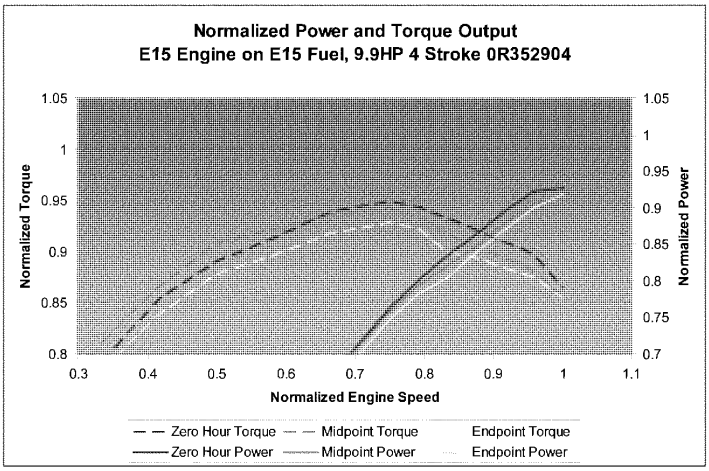


Figure 16: E15 Engine Power and Torque Output at Endurance Check Intervals-E15 Fuel

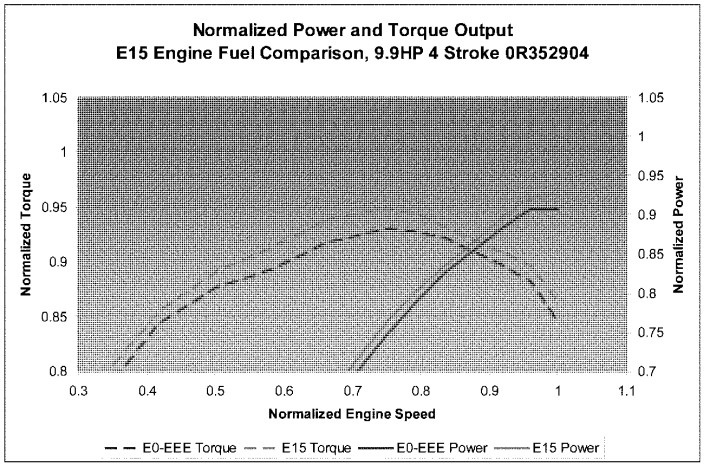


Figure 17: E15 Engine Power and Torque Output, Zero Hour Check-E0-EEE Fuel vs. E15 Fuel

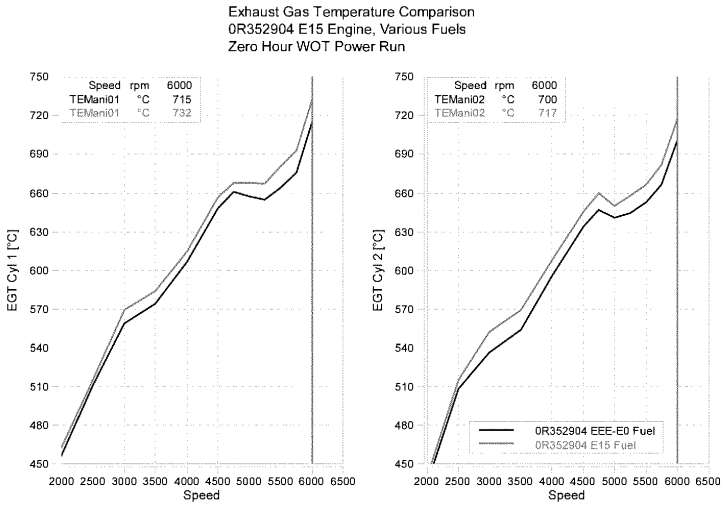


Figure 18: E15 Engine-Exhaust Gas Temperature Comparison, Zero Hour Check-E0-EEE Fuel vs. E15 Fuel

End of Test Teardown and Inspection

When the running engine testing was completed, the engines were disassembled and inspected. The main areas of focus were looking for signs of wear or deterioration and also material compatibility issues.

Upon initial inspection, there were indications that some of the main engine components on the E15 engine were subjected to higher operating temperatures. There were more carbon deposits observed on the undercrown area of the pistons and the small end of the connecting rod, suggesting that the pistons were operating at a higher temperature. Comparisons of the pistons and rods can be seen in Figures 19 and 20, respectively.

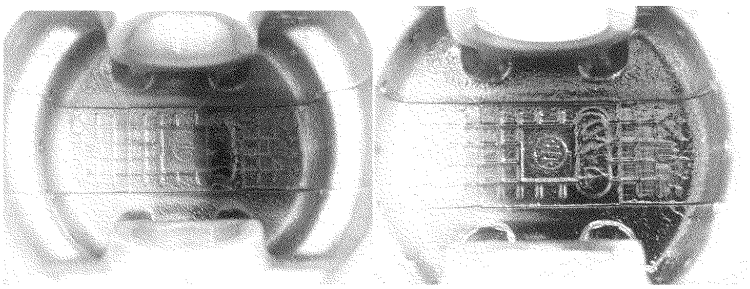


Figure 19: Piston Undercrown Carbon Deposit Comparison, Cylinder 1, E0 on Left, E15 on Right

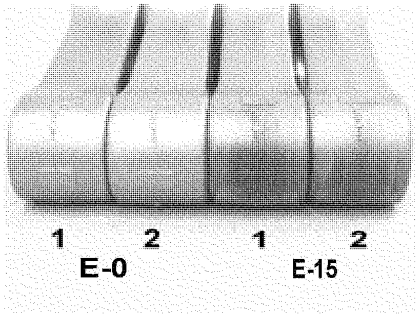


Figure 20: Small End of Connecting Rod Carbon Deposit Comparison, E0 on Left, E15 on Right

Although there were no indications of fuel pump failure during engine test, the mechanical fuel pumps were also disassembled and inspected following testing to look for abnormal signs of wear or degradation. The check valve gasket on the E15 engine showed signs of deterioration compared with that from the E0 engine. The gasket from the E15 pump had a pronounced ridge formed in the area that "hinged" when the check valve was in operation (see notes in Figure 21). The E15 gasket material in the area that sealed the check valve also had signs of wear that were more advanced than the E0 gasket. There was a significant amount material transfer from the gasket to the plastic check valve that it sealed as shown in Figure 22. Both fuel pumps were exposed to their respective test fuels for a period of approximately 2 months. More investigation is necessary to understand the effects of long term exposure of these components. It should be noted that the fuel pump flow performance was not tested. There were no indications that there was a problem with the fuel pump before disassembly. Once the deterioration was noted during teardown, it was determined that measuring the flow performance after disassembly and subsequent reassembly would have likely introduced error in the measurement.

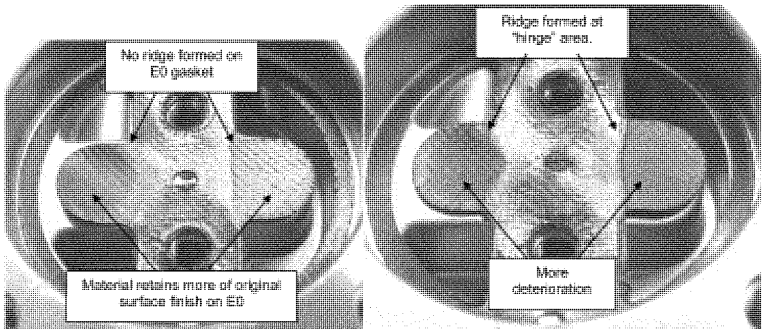

No ridge formed on E0 gasket
Material retains more of original surface finish on E0
Ridge formed at "hinge" area.
More deterioration

Figure 21: Fuel Pump Check Valve Gasket Comparison, E0 on Left, E15 on Right

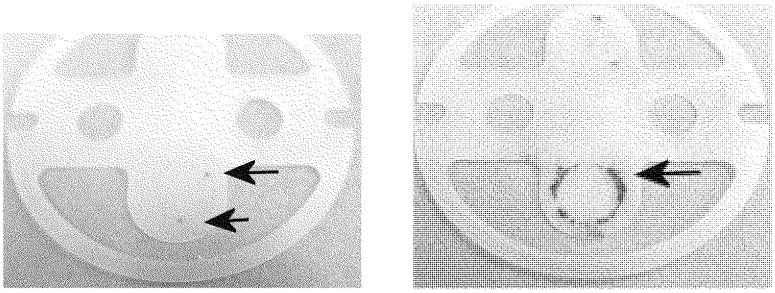


Figure 22: Fuel Pump Check Valve Comparison, E0 on Left, E15 on Right

Due to the visible differences in some of the engines' metal components, several components were sent to the in-house metallurgy lab for further analysis. Results of this analysis are included in Table 3. The Vickers hardness test was performed using a Clemet Microharness Tester with a conversion to the Rockwell C scale where applicable (on steel parts). The Brinell scale was used for the aluminum parts, as they are much softer than the steel parts. The values shown were the average of 3 measurements for each component with the exception of the valve bridge in the cylinder head where only 2 measurements were taken. However, due to the fact that only 1 component from each engine on the 2 fuels was tested the results have no statistical significance and should be taken as an indicator only. Also, no hardness measurements were taken on the components prior to testing so there was likely some normal part-to-part variability in hardness as the components were originally manufactured.

Taking all of these issues into consideration there were indications that some of the components had different hardness values. These differences were most likely related to the continuous operating temperatures of the components. The most notable differences were the pistons, the valve bridge in the cylinder head and the intake valve stems. The piston measured from the E15 engine had a hardness value approximately 13.2% lower than the piston from the E0 engine. This would suggest that the E15 piston experienced a higher operating temperature, as expected due to the lean

operation. The carbon deposits on the underside of the piston due to oil coking also suggest the E15 pistons were running hotter as noted previously. The intake valve stem measurements showed an approximately 12% difference in hardness, with the E0 engine having the lower values. This difference would suggest that the E0 intake valve stems were running hotter during operation than the E15. This difference was likely due to the charge-air cooling effect of ethanol in the E15 fuel resulting in cooling of the intake port and leading to lower intake valve stem temperatures. The evaporative cooling in the intake port could also explain why the valve bridge hardness measurements indicated that the valve bridge on the E15 engine had lower operating temperatures evidenced by the roughly 11% higher hardness value. The other measurements showed differences that were likely within the repeatability of the measurements and the manufacturing variability so no conclusions could be drawn from them.

The piston is generally a higher-stressed component than the intake valve. The reduction in hardness of the intake valve for the E0 engine is not likely to increase failure rates since this engine family was qualified for E0 operation as a baseline. However, if the reduction in hardness of the piston with E15 fuel was found to be a statistically significant result, E15 fuel usage might increase the failure rate of this component.

Table 3: Hardness Measurements on Various 9.9HP Four-Stroke Engine Components

9.9HP Four Stroke	Hardness Scale	**E0** 0R364814	**E15** 0R352904	Percent Difference
Piston, Cyl 1	BHN	91.0	79.0	13.2%
Connecting Rod, Small End Cyl 1	BHN	112.0	112.0	0.0%
Exhaust Valve Stem, Cyl 1	Rc	21.7	22.1	-2.0%
Exhaust Valve Head, Cyl 1	Rc	30.1	30.7	-2.0%
Valve Bridge in Cyl. Head, Cyl 1	BHN	83.0	92.0	-10.8%
Intake Valve Stem, Cyl 1	Rc	33.0	36.9	-11.9%
Intake Valve Head, Cyl 1	Rc	39.6	39.1	1.3%

Verado 300HP Supercharged Four-Stroke:

Endurance Test Results

Several engine failures occurred during endurance testing on the Verado engines, two of which were not related to the fuel and one of which may have been associated with the use of E15 fuel. The two non-fuel-related engine failures included a casting defect and a test facility induced failure. A third engine failure, involving failed exhaust valves is believed to have been caused by the E15 fuel. Failure mechanisms are described in detail below.

E0 Engine #1-Casting Defect: The first engine to fail was the E0 Verado-serial number 1B812775. At 177 hours of WOT endurance (204.2 total engine hours) the engine was shut down for a routine oil check. An excessive amount of water was found in the oil. The engine was disassembled and the major components were pressure checked. A leak path was discovered from the water jacket to the intake port on one cylinder. The cylinder head was sectioned and an oxide fold line from the casting process was discovered. This defect was present from the time of the original casting process and took thermal cycling, load, and time to cause a leak. It was in no way associated with the fuel.

E0 Engine #2-Test Facility-Induced Failure: An additional engine was obtained to replace the original E0 engine and this engine was given the serial number 1B821775A. This engine did the initial dyno tests and was put on endurance. After 88.7 hours of WOT endurance (98 total engine hours), the engine was automatically shut down by the endurance facility control system for low exhaust gas temperature. Investigation showed water entering the exhaust stream. The engine was then disassembled and a significant amount of mineral deposits were found in the cooling passages, especially in the exhaust collector on the cylinder head. See Figure 23. [Note: For a coolant fluid, outboard engines draw in water from the body of water they are operating in, which in this case was the endurance test tank.] An interaction between

the pH and hardness of the water in the test tank created conditions that precipitated out minerals (primarily calcite) when exposed to the elevated temperatures in the cooling passage, especially near the exhaust collector. The blocked passages prevented adequate cooling in the exhaust collector, which eventually failed the head gasket and allowed water to enter into the exhaust stream. See Figure 24. It should be noted that these water chemistry conditions were specifically caused by the test facility water conditioning and would not be something that the engine would experience in real-world use.

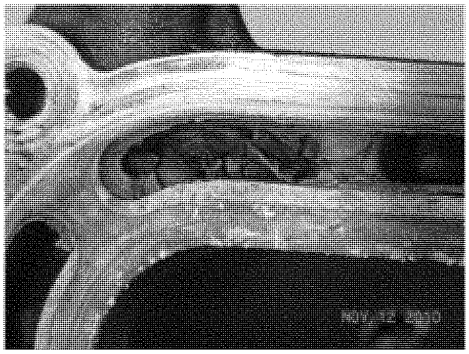


Figure 23: Mineral Deposits in Cooling Jacket, E0 Verado 1B812775A

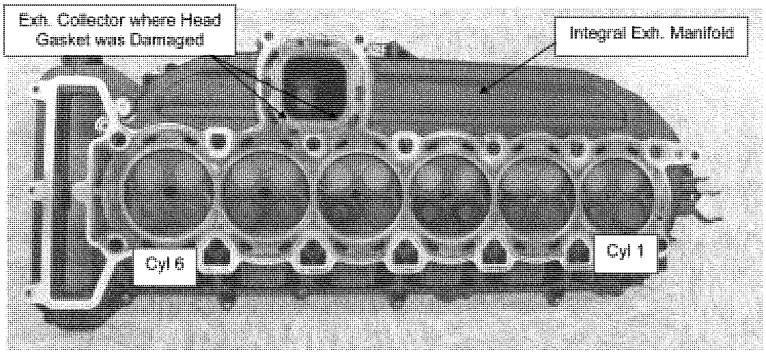


Figure 24: Verado Cylinder Head Indicating Where Head Gasket Failure Occurred, E0 Verado 1B812775A

E15 Engine: At 285 hours of endurance operation (323 total engine hours), the E15 Verado test engine (serial number 1B812776) was noted to have rough idle after restarting shortly after maintenance was performed. A compression check was performed showing no compression on cylinder 3. During disassembly a broken exhaust valve was found in cylinder #3. Further investigation found that the other exhaust valve on cylinder 3 had developed a crack, as well as one

of the exhaust valves in cylinder 6. See Figures 25 and 26. NOTE: The images shown in Figure 26 of the cracked exhaust valves had been cleaned of deposits prior to photography.

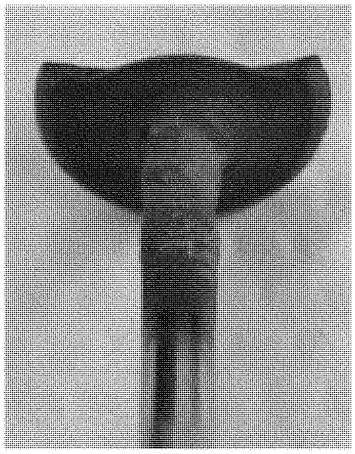


Figure 25: Broken Exhaust Valve from E15 Verado 1B812776, Top Valve in Cylinder 3

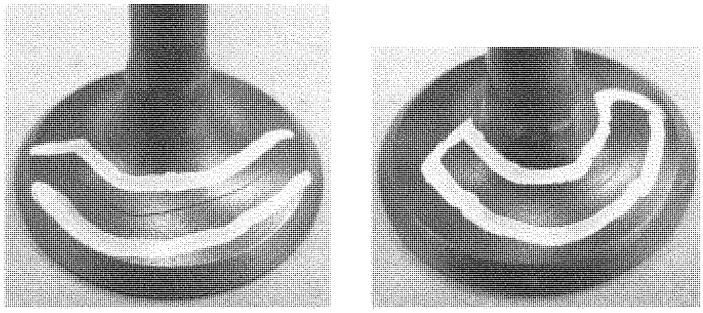


Figure 26: Cracked Valves from E15 Verado 1B812776, Bottom Valve in Cyl. 3 Left, and Top Valve in Cyl. 6 Right

The cracked valves and several valves without cracks from the E15 Verado were analyzed in Mercury's materials laboratory. The cracked valves were visually inspected with an optical stereoscope. The fatigue initiation sites were clearly identified. Figure 27 shows an example of the images of the initiation sites from the bottom exhaust valve from cylinder 3.

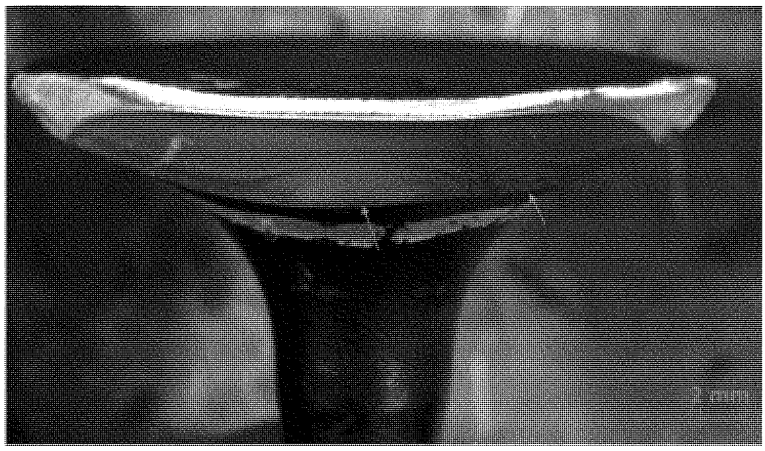


Figure 27: Fatigue Initiation Sites on Cylinder 3 Bottom Exhaust Valve, E15 Verado 1B812776

In addition to finding the fatigue initiation sites, the failed valves were checked for hardness. The cracked valves from the E15 engine were found to have hardness values much lower than new valves and below the minimum print specification of a new valve. Other sample valves were collected and analyzed from WOT endurance Verado engines that were run on E0 pump fuel during the same general timeframe as the E15 engine was run. In addition, samples of new valves were also acquired and analyzed. The hardness measurements showed that the valves from the engines operated on E0 fuel were actually harder than the new valves. The summary of hardness measurements are shown in Table 4. Note: All of the measurements were taken in the Rockwell A scale and converted to the Rockwell C scale due to the fact that the samples were mounted and polished to perform hardness measurements in the center of the cross section. This would negate any hardness effects from the mounting material.

Table 4: Verado Exhaust Valve Hardness Measurement Summary

Valve Description	Hardness (HRC)
E15: 1B812776 Cyl 3 Bottom	22
E15: 1B812776 Cyl 6 Top	22
E0: 1B812775 Cyl 3 Bottom	37.5
E0: 1B812775 Cyl 3 Top	36.5
E0: 1B812775A Cyl 3 Top	38
E0: 1B828629 Cyl 2 Top	37.5
New Valve #1	34.5
New Valve #2	34.5
New Valve #3	33
New Valve #4	33
New Valve #5	33.5

The Verado exhaust valves are made from Inconel 751, which is a heat-treatable alloy. This trait was used to estimate the metal temperatures experienced by the valves. The valve hardness data in Table 4 collected from the E0 engines

suggested that the metal temperatures experienced during operation were in a range that allowed age-hardening of the metal to make the valves increase in hardness. The hardness values of the E15 engine valves suggested that they were operating in a temperature regime that significantly reduced the hardness. In order to understand the hardness versus temperature, the new valves that were hardness checked were heated in an oven for 24 hours at various temperatures and then hardness was checked again. Figure 28 shows the results from the oven heating operation on the new valves. In Figure 28, the blue line shows the hardness data of the new valves before heat treatment and the red line shows the hardness data of the valves after heating. At metal temperatures above 870°C, the valves showed a dramatic decline in hardness according to this test data. The data suggest that the exhaust valves from the E15 engine may have experienced temperatures nearing 900°C.

One possible mechanism by which the E15 exhaust valves may have experienced such high temperatures would be a disruption of valve cooling during the portion of the cycle where the valve should be fully seated. During inspection, it was noted that several cam lobes showed wear and marking on the base circle portion of the lobe indicating that the exhaust valves had run out of lash. This suggested that excessive wear or valve head deformation may have occurred during operation, which caused the lash to diminish. This would have prevented the valve from seating properly resulting in a significant valve temperature increase due to lack of cooling on the seat. The valves or seats may have also had accelerated wear to diminish the lash due to lack of lubricity of the E15 fuel or because of the elevated temperatures caused by the lean operation on E15 fuel. In addition, if the exhaust valves were experiencing higher operating temperatures due to the higher exhaust gas temperatures from using E15 fuel, the overall length of the valve would be slightly longer. This longer length during operation would also reduce the amount of lash in the valvetrain and make the engine more prone to base circle contact on the cam. Plots comparing the measured cold valve lash over the course of endurance between the E0 and E15 engines are shown in Figures 32 and 33 below.

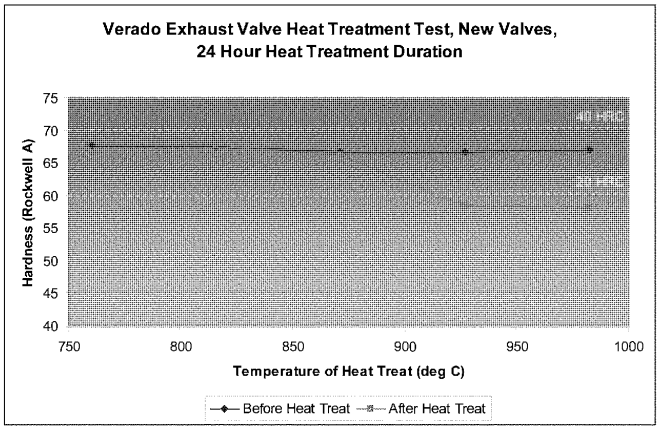


Figure 28: Heat Treatment Test of New Verado Valves

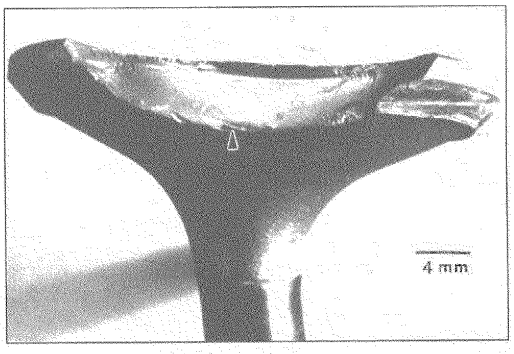


Figure 6.8 *Example of valve fillet fractures due to overstress, at elevated temperatures, and a corrosive environment; the arrow shows the crack initiation site at the fillet (Wang* et al.*).*

Figure 29: Exhaust Valve Failure from Literature Research Showed Similar Failure Mechanism [8]

Similar failure mechanisms were found in a literature search as shown in Figure 29. The failure is noted as a classic over-temperature failure. *"High temperatures and a corrosive environment at the exhaust fillet substantially weaken the valve strength."*[8] from: Introduction to Engine Valvetrains by Yushu Wang

Extensive development went into the valvetrain on this high-output engine. Upgrading the engine to account for higher exhaust gas temperatures due to a wider range of fuel properties would not be easily accomplished. The current production Verado exhaust valve is Inconel 751, which is categorized in the "superalloy" material classification.

It should be noted that the E15 engine (1B812776) was operating for a period of time when the mineral precipitation problem occurred on the second E0 engine (1B812775A). However, it is not believed that this contributed to the valve failure. The E15 engine (1B812776) did have some accumulation of precipitation flakes in the exhaust collector area, but not nearly to the extent that the E0 engine did. The E15 engine (1B812776) was not operating the entire time the E0 engine (1B812775A) ran when the mineral precipitation problem occurred. The head was sectioned and there were no mineral precipitation deposits on cooling jacket surfaces in cylinder 3 where the worst valve failure occurred. See Figure 30 for a picture of the sectioned head from the E15 engine (1B812776) showing no mineral deposits were present. Yellow spots in the cooling jacket were anti-corrosion coating from production where the paint did not fully coat interior surfaces of the cooling jacket. Figure 31 shows the same section of cylinder head from the E0 engine (1B812775A) that failed due to the mineral precipitation. This E0 engine (1B812775A) was also inspected for cracked exhaust valves and none were found. In addition, the hardness values of the exhaust valves were measured (see Table 4) indicating that the mineral precipitation issue did not affect the valve hardness on the E0 engine (1B812775A). There were several other Verado engines that were running endurance testing for a different project that failed due to the mineral precipitation issue. All other Verado engines that failed due to the mineral precipitation failed the head gasket in the exhaust collector area.

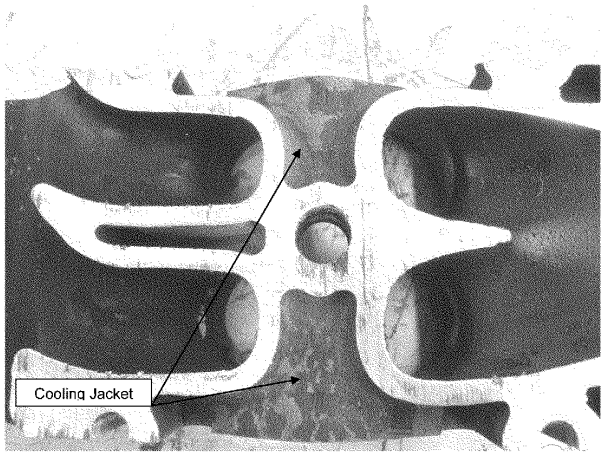


Figure 30: Photo of Section of Cylinder 3, E15 Verado 1B812776, Exhaust Ports on Left

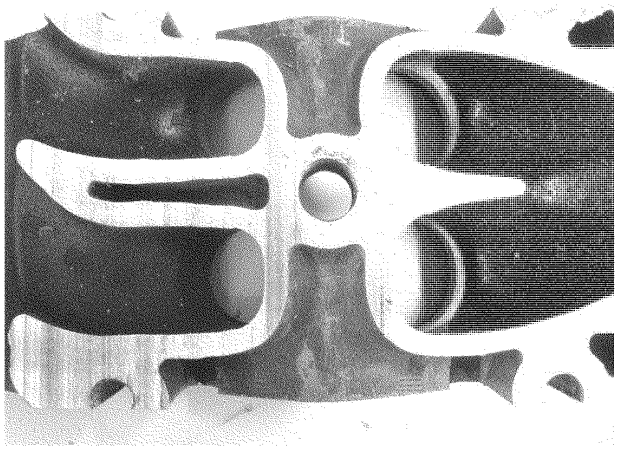


Figure 31: Photo of Section of Cylinder 3, E0 Verado 1B812775A, Exhaust Ports on Left

E0 Substitute Engine: In lieu of a completed test on E0 fuel, a substitute engine was chosen that had already been through endurance testing (serial number 1B828592). The engine that was used as a substitute had completed 372 hours of WOT endurance testing and was still intact. It ran in the same test facility running under the same test procedure as all other endurance testing as part of this project. The engine was used for a gearcase durability test for a different project so the rest of the engine was completely stock and built on the production line as were the other engines in this project. As such, it provided a suitable replacement for the incomplete E0 tests. For reference, the replacement engine (1B828592) was on test between the following dates: 11/15/2010 through 12/14/2010. The E15 engine 1B812776 was on test between 9/21/2010 through 11/12/2010.

As part of routine maintenance and checks during endurance, several valve lash measurements were taken at various intervals on the E0 substitute engine. Figures 32 and 33 below show the lash measurements during the course of endurance for both the E0 substitute engine (1B828592) and the E15 engine (1B812776), respectively. The solid red lines in the graph indicate the upper and lower lash specification on a new engine. It is clear from the lash measurements on the 2 engines that the E15 engine had a significantly faster decline in lash than the E0 substitute engine. The E0 substitute engine had 1 valve with higher lash value at the end of testing. There may have been some carbon or other deposits holding this valve off the seat during the measurement.

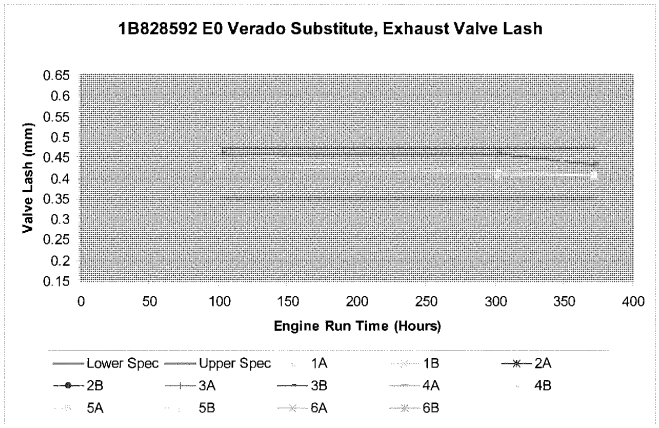


Figure 32: Exhaust Valve Lash (Measured Cold) vs. Endurance Time, E0 Substitute Engine

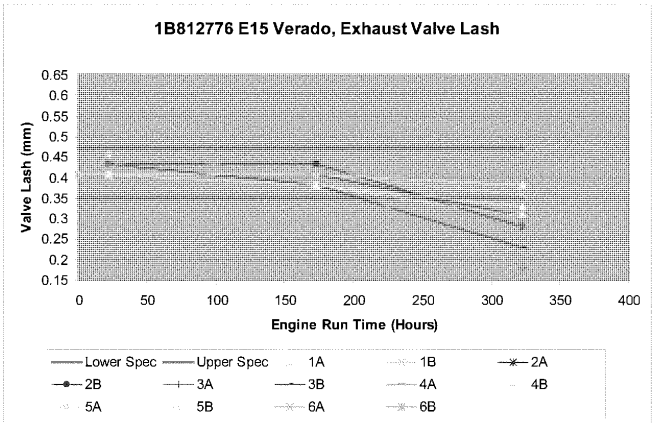


Figure 33: Exhaust Valve Lash (Measured Cold) vs. Endurance Time, E15 Engine

Emissions Testing Results

Due to failures of both the E0 and E15 engines, a complete analysis of the deteriorated emissions was not possible. However, with the data available several conclusions could be made. Figure 34 shows a graph of the Verado emissions that were collected. As was the case for the 9.9HP emissions data plots, each data point on the curve represents the average emissions value of the 3 emissions tests performed at each interval with error bars showing the range of the 3 emissions tests. The dashed yellow line shows the data from the original E0 engine (serial number 1B812775). The solid red and blue lines show the emissions data from the E15 engine (serial number 1B812776) using E15 and E0 (EEE) fuels, respectively. The single point in light blue at 372 hours shows the end of test emissions results for the substitute E0 engine (EEE fuel, serial number 1B828592). The graph shows a generally declining HC+NOx trend for the 2 original engines which is typical of Verado engines. The declining emissions trends on both engines would suggest that the ethanol fuel blend did not adversely affect the emissions deterioration on the Verado engine. The most notable aspect of the emissions output on the E15 engine was the fact that the total HC+NOx on E15 fuel was above 25 g/kw-hr, whereas the value on EEE-E0 was 21.5 g/kw-hr. The Family Emissions Limit (FEL) was set to 22 g/kw-hr for this engine family. A Verado engine generating 25 g/kw-hr would have failed an emissions audit. The increase in emissions can be primarily attributed to a significant increase in NOx due to the lean operation. Since the Verado is a highly boosted engine it is very sensitive to NOx generation due to changes in equivalence ratio. However, there was also an increase in HC emissions due to the E15 fuel, which would not be expected with a leaner equivalence ratio.

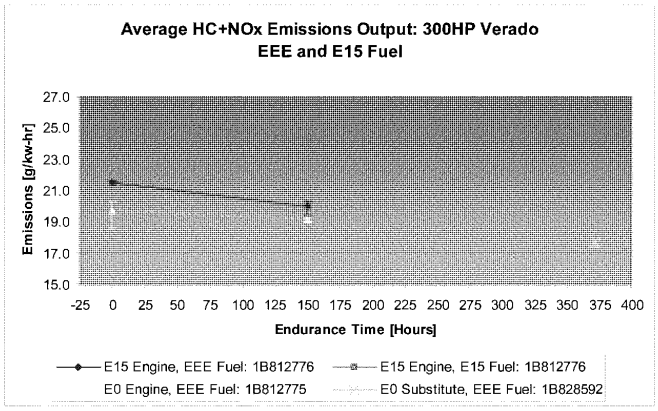


Figure 34: 300HP Verado HC+NOx Emissions Results Summary

In order to better understand the differences in the emissions outputs between the 2 fuels, graphs were made for each constituent of interest. Figures 35 through 37 show the NOx, HC, and CO emissions differences. The graphs were broken down by mode point for emissions tests performed prior to endurance on the E15 engine (1B812776). The values shown are the averages of the three repeated runs at "zero" hours.

Figure 35 shows the NOx emissions trends for the 2 fuels. The main differences were at Modes 1 and 2 which were both high load, boosted operating points. The fact that the NOx increased significantly with a lean shift due to the ethanol fuel blend was not surprising. Modes 3 and 4 did not show much difference because the engine was calibrated near an equivalence ratio of 1 on E0 fuel. The NOx trend with respect to equivalence ratio was near the peak at these points so a lean shift did not result in a significant change in NOx. Mode 5 was idle so the NOx generation at that point was essentially zero.

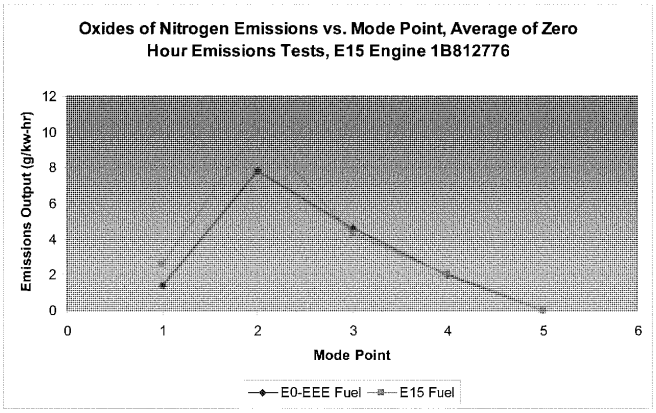


Figure 35: 300HP Verado NOx Emissions Results by Mode Point, Representative Zero Hour Test Data

The increase in HC output on E15 fuel was not an expected outcome of the test. Figure 36 highlights the difference in HC emissions between the 2 fuels. The main difference occurred at Mode 3, so further investigation was necessary into Mode 3 data specifically. However, it was also apparent that the HC output on E15 fuel was higher at Modes 1-4 despite the leaner operation from the fuel chemistry. This may suggest that the vaporization of the E15 fuel was inferior to that of the EEE fuel leading to poor fuel preparation. This is supported by data from Modes 1 and 2 where NOx and CO trends show that the engine did run leaner, yet had higher HC output when operated with E15.

The HC difference at Mode 3 was likely a result of the engine running substantially leaner than lean best torque (LBT). In this operating region, the Verado engine is calibrated slightly lean of the stoichiometric mixture on E0 fuel. With the use of E15 fuel, the engine operates significantly lean of LBT and, therefore, the torque production diminishes significantly. As a result, to achieve the specified torque set point for Mode 3 the throttle input had to be increased, yielding higher airflow and higher fuel flow. The fuel flow increased nearly 10% for essentially the same torque production with E15 fuel. In addition, it was noted that the intake air temperature was 12°C cooler at Mode 3 with E15 fuel. The cooler charge temperature was likely a result of the increased fuel vaporization cooling effect from the ethanol. The cooler temperatures in the intake may have impaired fuel preparation. The higher fuel flow combined with the inferior fuel preparation was likely the cause of the high HC output at Mode 3.

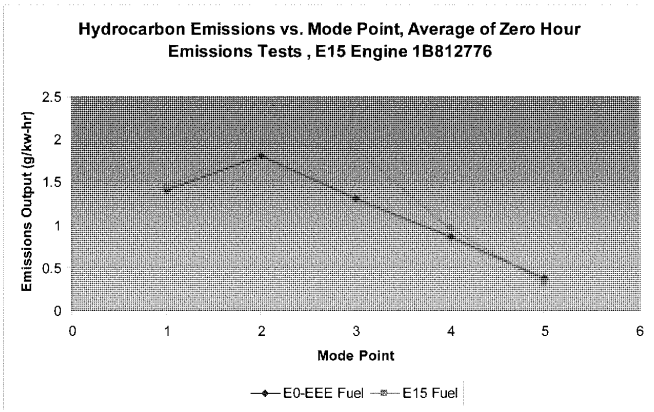


Figure 36: 300HP Verado HC Emissions Results by Mode Point, Representative Zero Hour Test Data

The CO emissions vs. emissions test mode point are shown in Figure 37. There was a significant reduction in CO emissions at Modes 1 and 2 when the engine was operated on E15 fuel, as expected. Modes 1 and 2 are calibrated rich of a stoichiometric mixture on E0, so the enleanment from E15 caused a reduction in CO. Modes 3-5 are generally insensitive in regard to CO because the operating points are calibrated near the stoichiometric mixture, so leaning the engine out due to the fuel had little effect at reducing CO relative to the changes seen at Modes 1 and 2.

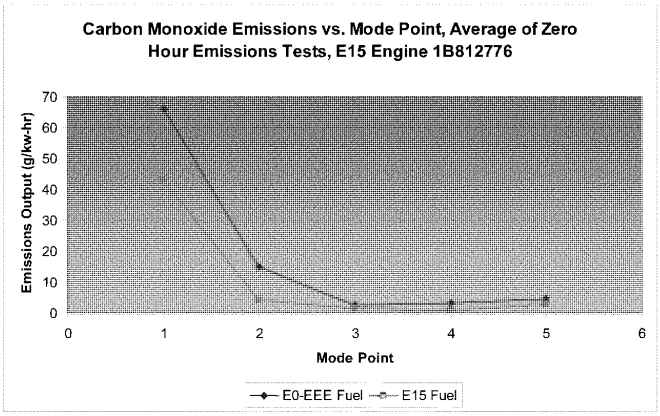


Figure 37: 300HP Verado CO Emissions Results by Mode Point, Representative Zero Hour Test Data

Engine Performance Comparison

Due to the engine failures, a complete comparison of engine performance vs. run time was not possible. The normalized power and torque data from the E0 Verado is shown in Figure 38. The changes from zero hours to 150 hours were less than 1% for peak torque (negligible) and a 2.3% reduction in peak power. The E0 engine produced less power output than the E15 engine when operated on the same E0 fuel. This difference of approximately 2% is considered normal production engine-to-engine variability.

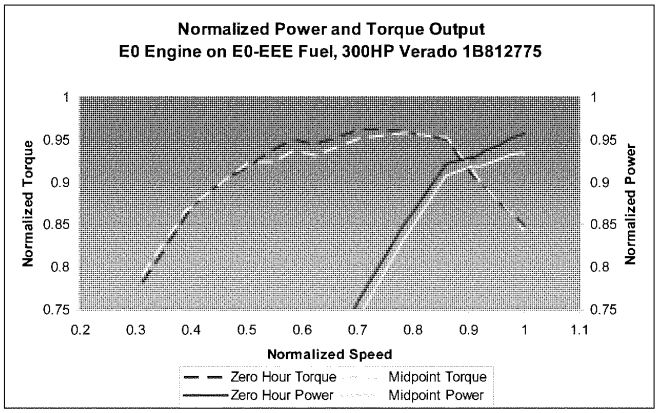


Figure 38: E0 Engine Power and Torque Output at Endurance Check Intervals-EEE-E0 Fuel

Power and torque data (normalized) for the E15 engine on both EEE-E0 fuel and E15 fuel is shown in Figure 39. There was an improvement in peak torque of 3.0% and in peak power of 1.5% when comparing the zero hour and midpoint runs on E0-EEE. The E15 engine showed negligible differences when comparing the midpoint power runs on E0-EEE and E15. It is unclear why this engine seemed unresponsive to the differences in charge cooling afforded by the ethanol blend fuel. Note: There was not a power run completed on E15 fuel at the initial zero hour measurement, which is why the midpoint data is compared in these figures.

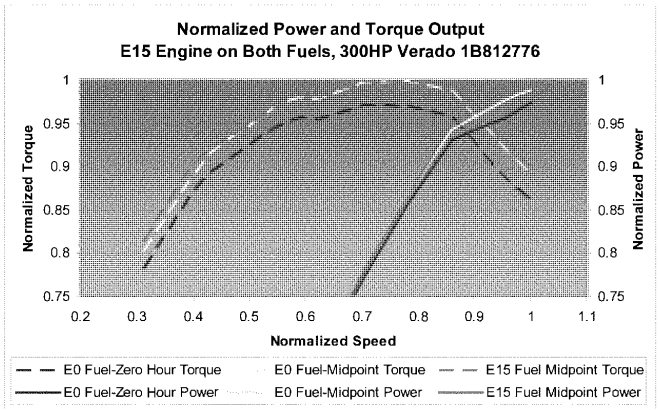


Figure 39: E15 Engine Power and Torque Output at Endurance Check Intervals-EEE-E0 and E15 Fuel

Figure 40 shows the difference in exhaust gas temperatures during power runs at the midpoint check on the 2 different fuels. There was up to a 30°C increase in EGT when operating on E15 fuel.

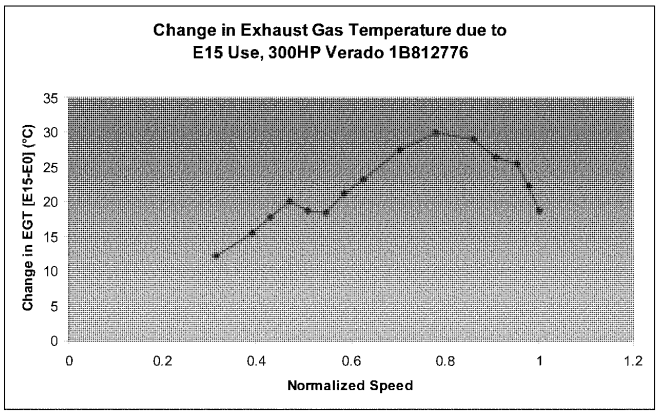


Figure 40: E15 Engine-Exhaust Gas Temperature Change at Wide Open Throttle, EEE-E0 to E15 Fuel

End of Test Teardown and Inspection

After all running engine tests were completed, the engines were disassembled and inspected. There was visual evidence that some of the internal components from the Verado E15 engine had experienced higher operating temperatures.

Upon disassembly, there were differences noted in the condition of the pistons from the 2 engines. Figure 41 shows pictures comparing the pistons from cylinder 2 from each engine. The piston from the E15 engine had a significantly higher amount of oil staining and carbon deposits than the piston from the E0 engine. The staining and deposits were noted on nearly every surface of the E15 piston compared with the E0 piston. Additionally, the pistons were sent to the metallurgy lab for hardness measurements. The hardness measurements were taken at several locations on the crown of the piston as well as a location on the internal portion of the piston just above the wrist pin bore after being sectioned. The average crown hardness of the E0 piston was 67.5 BHN (Brinell Hardness Number) while the E15 piston crown was 66.9 BHN. The internal piston hardness above the wrist pin bore was 74.1 BHN for the E0 piston and 71.5 BHN for the E15 engine's piston. Although the hardness measurements showed no effect of operating temperature on material properties, differences in visual appearance suggest that the E15 pistons operated at higher temperatures during running than the E0 pistons.

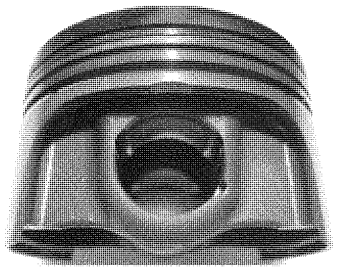


Figure 41: Piston Carbon Deposit Comparison, Cylinder 2, E0 on Left, E15 on Right

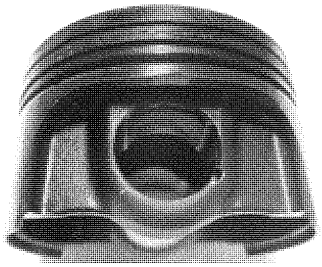


Figure 42 shows the small end of the connecting rods from each engine. The carbon deposits indicate that the E15 rods likely ran at higher operating temperatures. The carbon deposits on the rods are consistent with the carbon deposits observed on the pistons.

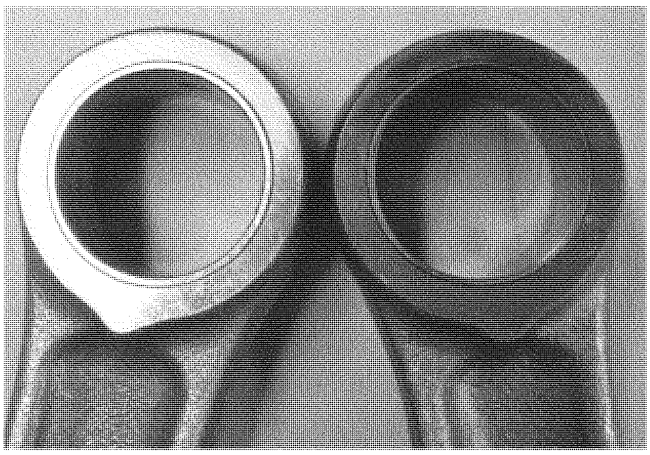


Figure 42: Connecting Rod Carbon Deposit Comparison, Cylinder 2, E0 on Left, E15 on Right

The exhaust valves were also closely inspected on the substitute E0 engine in order to compare with the valves that cracked on the E15 engine. With 372 hours of endurance aging time accumulated, no cracked valves were discovered during inspection under a microscope. The average hardness values of the exhaust valves from cylinder three of the E0 engine were 37.3 and 37.7 HRC. These values were consistent with other engines that were operated on E0 as indicated in Table 4.

During disassembly, the E15 engine was noted as having base circle contact on several of the exhaust cam lobes as noted above. The exhaust cam lobes from the substitute E0 engine did not show signs of base circle contact. The lash measurements shown in Figures 32 and 33 support these observations. A picture showing the difference in wear on the base circles of the exhaust cam lobes can be seen in Figure 43. The picture shows the E15 exhaust cam on the right and the E0 cam on the left. The wear pattern on the E15 exhaust cam lobe is apparent.

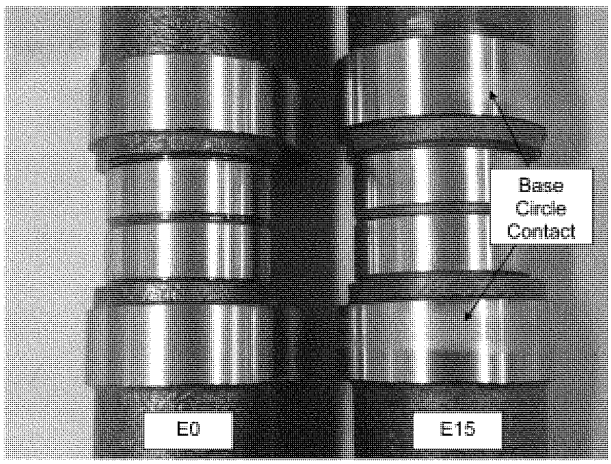


Figure 43: Exhaust Cam Lobe Base Circle Detail, Cylinder 3, E0 on Left, E15 on Right

200 EFI Two-Stroke:

Endurance Test Results

An engine failure prevented successful completion of the full endurance period for the 200 EFI E15 engine. The 200 EFI E15 engine failed a rod bearing before the completion of the endurance test. The 200 EFI E0 engine completed the 300 hour endurance test and all post-endurance dynamometer tests.

The E15 endurance engine failed at 283 total engine hours and had accumulated 256 hours of WOT endurance at the time of failure. Upon inspection it was found that the big end connecting rod bearing had failed on cylinder 3. The rod cap was still bolted to the rod after the failure. This engine family uses a fractured rod cap design with a roller bearing (typical for a two-stroke vs. a plain bearing in a four-stroke). Images of the remaining bearing cage and the damaged rod along with undamaged pieces for reference are shown in Figure 44. No rollers were found during teardown and were likely ejected from the bearing and made their way through the power cylinder and out the exhaust. There was extensive damage to the top of the piston on cylinder 3 indicating that the rollers went through the power cylinder. Due to the extensive damage to the bearing and connecting rod (since it failed at rated speed, full power) and the fact that not all of the pieces were recovered, root cause of the bearing failure was not conclusively determined. Little is known about the effects of ethanol blends on oil/fuel mixing and dispersion on total loss lubrication systems, such as the one on this engine family. More investigation is needed to understand if ethanol would negatively impact the lubrication systems on two-stroke engines.

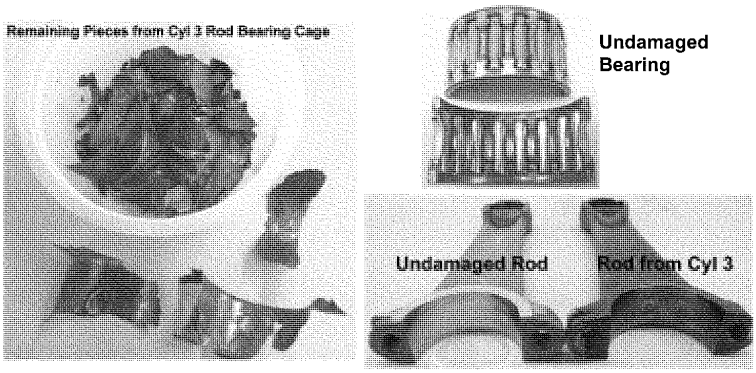


Figure 44: 200HP EFI Bearing Failure Pictures

Emissions Testing Results

As a result of the engine failure, a complete set of emissions data was not collected on the 200 EFI. However, conclusions can be drawn from the data that were collected. Figure 45 shows a summary of HC+NOx results from the emissions test on both engines. As Figure 45 shows, there was more variability in the E0 engine than on the E15 engine. E15 fuel did not have a detrimental effect on emissions degradation on this engine family. It is worth noting that of the roughly 120 g/kw-hr of HC+NOx, the NOx contribution is approximately 2 g/kw-hr. Since the HC is roughly 98% of the total HC+NOx, graphs depicting the changes in the individual constituents were left out of this report. The relative enleanment from the E15 fuel did slightly increase the NOx emissions, but that was not significant in comparison with the HC contribution.

The CO emission results from the 200 EFI engines are shown in Figure 46. The E15 fuel resulted in lower CO emissions, as expected due to the relative enleanment from the difference in fuel chemistry. Both engines and both fuels showed the same trend of increasing CO with more endurance time.

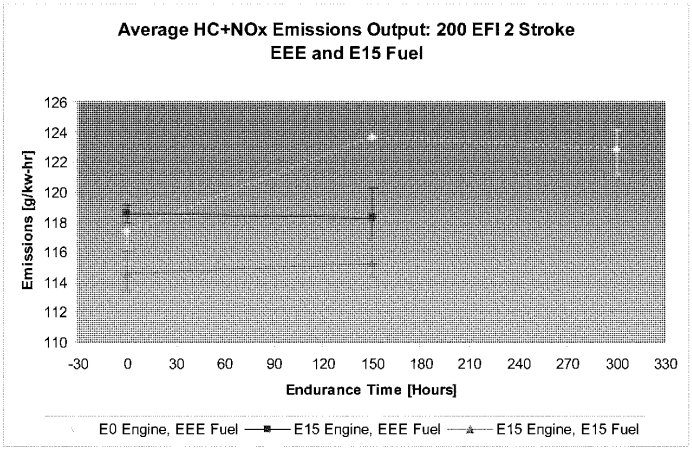


Figure 45: 200HP Two-Stroke HC+NOx Emission Results Summary

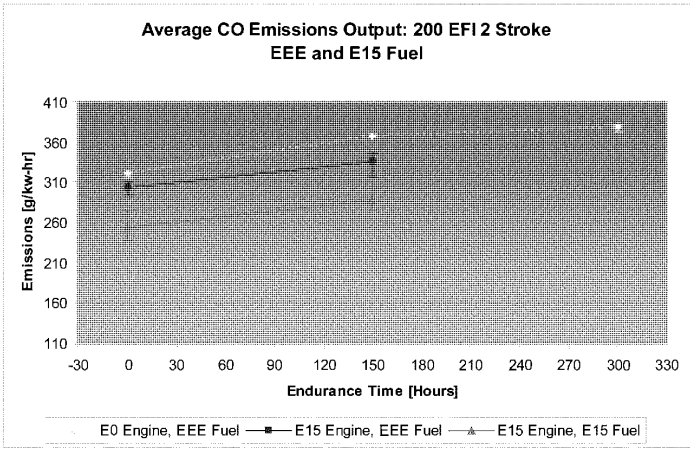


Figure 46: 200HP Two-Stroke CO Emission Results Summary

Engine Performance Comparison

The power and torque data (corrected per ISO 3046-1) from the E0 200HP EFI engine are shown in Figure 47. There were slight differences in the curves, but the changes from zero hours to 300 hours were less than 1% for both peak torque and peak power.

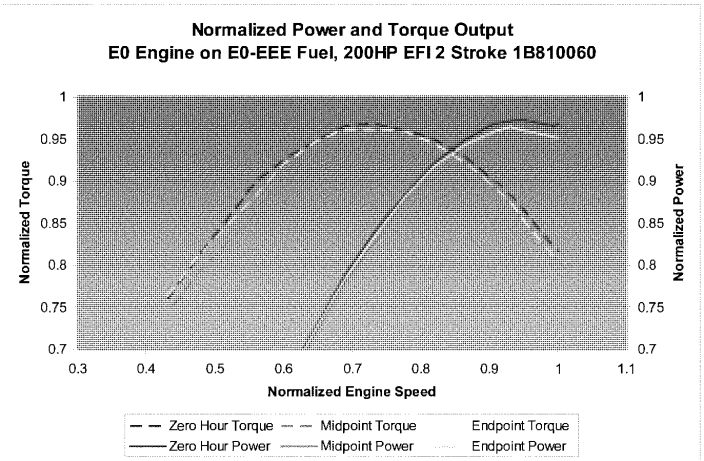


Figure 47: E0 Engine Power and Torque Output at Endurance Check Intervals-EEE-E0 Fuel

Data for the E15 engine on both EEE-E0 fuel and E15 fuel are shown in Figure 48. A comparison of the output at the zero hour and 150 hour checks are included. Similar to the E0 engine, there was less than a 1% change from the zero hour check to the 150 hour check for both the peak torque and peak horsepower for either fuel. There was an increase of approximately 2% in both peak torque and peak power when changing from E0 to E15 fuel. The engine may have been operating in a range closer to the Lean Best Torque on the E15 fuel due to the enleanment from the fuel change and/or the volumetric efficiency may have been better due to the additional charge cooling of the ethanol fraction. Figure 49 shows the difference in exhaust gas temperatures during the same power runs on the 2 different fuels. Since this was a 6 cylinder engine and individual cylinder measurements were possible, the average and maximum changes in EGT were plotted for clarity. On average use of the E15 fuel resulted in a 15-20°C increase in EGT in the range of frequent steady-state operation (>4500 RPM). The maximum increase in EGT for any individual cylinder when using E15 was 28°C.

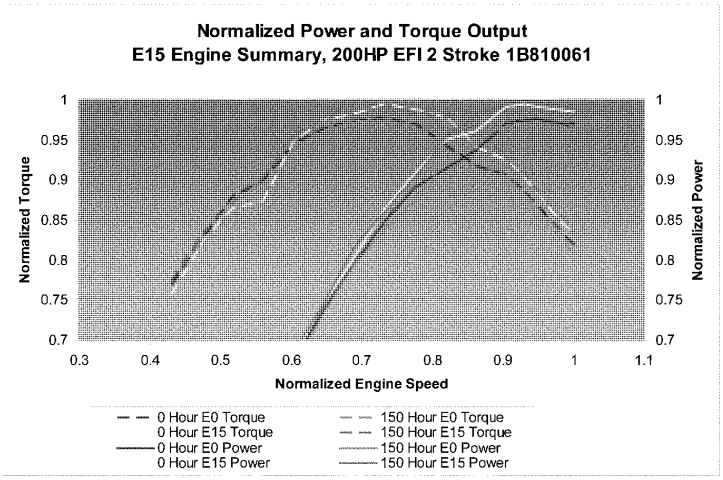


Figure 48: E15 Engine Power and Torque Output at Endurance Check Intervals-EEE-E0 and E15 Fuel

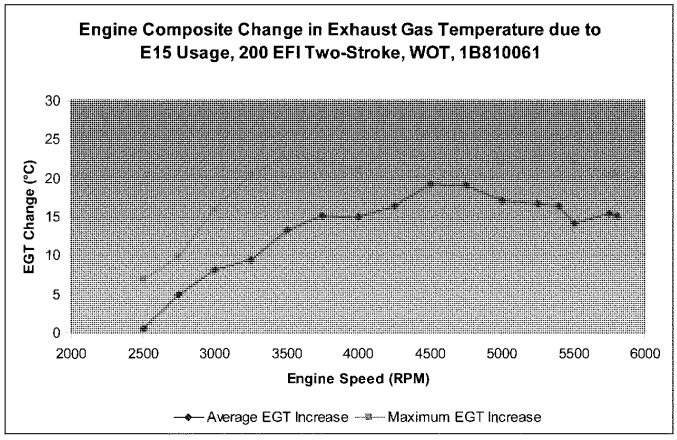


Figure 49: E15 Engine-Exhaust Gas Temperature Change at Wide Open Throttle, EEE-E0 to E15 Fuel

End of Test Teardown and Inspection

As was the case for the other engine families, the main areas of focus during teardown were looking for signs of wear and also material compatibility issues. Visual inspection of the components of the 2 engines did not suggest significant differences between them (aside from the rod bearing failure). In particular, the bore finish, carbon deposits, bearings from the small and big end of the rod, and main bearings were inspected for signs of mechanical or thermal distress and accelerated wear. No significant differences were noted aside from slight differences in the appearance of the wrist pins, as shown in Figure 50.

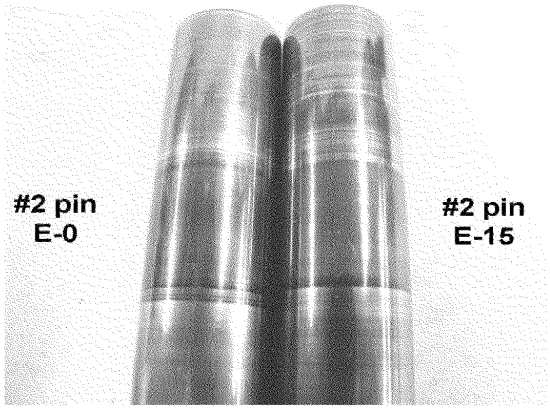


Figure 50: Cylinder 2 Wrist Pin Comparison, E0 on Left, E15 on Right

To provide a more in-depth analysis, selected components were further inspected. Using the same techniques as applied to the 9.9HP four-stroke components, the pistons and wrist pins from cylinder 2 on the 200HP EFI two-stroke engines were checked for material hardness. The results can be seen in Table 5. There were no significant differences in the hardness between the wrist pins, but there was a slight difference in hardness of the pistons (6.3%). The lower hardness of the piston on the E15 engine suggested it may have been running at higher temperatures. The nature of two-stroke engines causes them to be very sensitive to piston fit/piston temperature. An increase in piston temperature caused by fuel differences could cause increased propensity for power cylinder failures for customers. The slight difference in hardness was near the limit of repeatability for the test method so the results should be considered an indicator only. More testing would be necessary to gain confidence with a statistically significant sample size.

Table 5: Hardness Measurements on Various 200HP EFI Two-Stroke Engine Components

2.5L 200HP EFI	Hardness Scale	**E0** 1B860010	**E15** 1B810061	Percent Difference
Piston Wrist Pin, Cyl 2	Rc	54.7	54.1	1.1%
Piston Crown, Cyl 2	BHN	63.0	59.0	6.3%

In addition, the high pressure fuel pumps from both engines were sent to the pump manufacturer for flow testing. There were no significant differences in pump output between the 2 pumps, and they were within expected flow ranges for end of life components.

Additional Testing

4.3L V6 Catalyzed Sterndrive Emissions Comparison

Since the E15 fuel and a catalyzed engine were both readily available in the test lab, additional testing was performed beyond the test program requirements. Emissions tests were performed on E0-EEE fuel and E15 test fuel to determine any immediate impacts of increased ethanol for this engine family. No durability testing was performed. The 4.3L V6 sterndrive engine (General Motors V6 that was adapted and modified for marine use) was equipped with closed-loop electronic fuel injection and exhaust catalysts. The standard calibration for this engine in Mode 1 operation (rated speed and power) was such that the engine ran rich of stoichiometric to control exhaust gas temperatures. This is a common engine control approach to protect components during high power operation. For the type of exhaust gas oxygen sensor used on this engine, rich operation allows for no feedback control of the fuel air mixture. As such, the engine ran open-loop at Mode 1. All other modes ran closed-loop. The 5 mode HC+NOx and CO emissions totals were lower on E15 fuel due to the fact that the engine ran approximately 4.5% leaner on the E15 fuel at Mode 1. The HC+NOx at Mode 1 changed from 1.18 g/kw-hr on EEE to 1.10 g/kw-hr on E15. This small reduction was driven by the reduction of HC emissions. The NOx emissions increased on E15, but not as much as the HC decreased, yielding an overall lower total. The CO at Mode 1 was reduced from 45.6 g/kw-hr on EEE to 29.8 g/kw-hr on E15. The reduction of CO was attributed to the leaner operation at Mode 1. The HC+NOx and CO values for the remainder of the mode points were essentially the same since the closed loop fuel control allowed the engine to run at the same equivalence ratio. See Figure 51 for details of the emissions outputs.

The leaner operation at wide open throttle (Mode 1) caused an increase in exhaust gas temperatures when operating on E15 fuel. The exhaust gas temperature increase across all 6 cylinders was approximately 20°C. The elevated EGT during WOT operation could cause valvetrain durability issues. The catalyst temperatures were approximately 32°C higher at Mode 1 with E15 fuel. This increase in catalyst temperature at WOT would likely cause more rapid deterioration of the catalyst system leading to higher exhaust emissions over the lifetime of the engine. The full impact of E15 on catalyst life would depend on the duty cycle of this engine in actual application. Typical duty cycles of marine engines include considerable amounts of time at WOT operation (open loop) so the catalyst temperature increase is of concern.

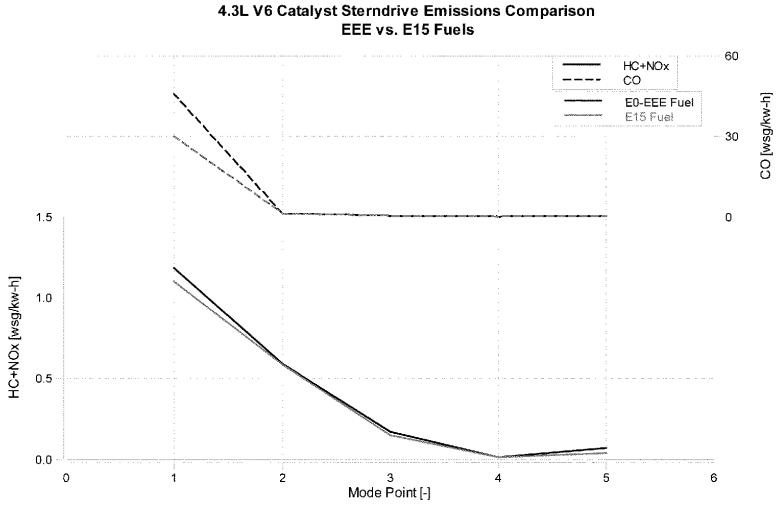


Figure 51: Emissions Comparison 4.3L V6 Catalyst Sterndrive, EEE vs. E15

The other aspect that was affected by running E15 on the closed-loop controlled engine was the fuel consumption. Since the closed-loop control system drove to an equivalence ratio, the fuel flow rate increased to account for the differences in fuel chemistry. Table 6 shows the fuel flow measurements by mode point along with the percent difference in fuel flow between the 2 fuels (positive values mean E15 fuel flow is higher). In closed-loop operation, the fuel flow increased 5.3% on average on E15 fuel. This increase in fuel flow causes concerns not just in fuel mileage, but also in useful range of the craft.

Table 6: Fuel Flow Comparison on 4.3L V6 Catalyst Sterndrive, EEE vs. E15

	EEE	E15	
Mode	Fuel Flow	Fuel Flow	Difference
	kg/hr	kg/hr	%
1	46.8	47.0	0.4%
2	24.2	25.5	5.3%
3	13.1	13.7	4.7%
4	7.1	7.5	5.2%
5	2.0	2.1	5.9%

Mode 2-4 Average 5.3%

Final Summary

Summary of Results:

EPA's recent announcement of a partial waiver approving E15 fuel for use in 2001 and newer cars and light trucks[9] will create an opportunity for consumers to misfuel their marine engines. This program indicates that misfueling currently available marine outboard engines may cause a variety of issues for outboard engine owners. These issues included driveability, materials compatibility, increased emissions, and long-term durability. There were also 2 examples of how the ethanol fuel caused an increase in fuel consumption.

9.9HP Carbureted Four-Stroke:

The E15 engine showed high variability in HC emissions at idle during the emissions tests at the end of the 300 hour endurance period. Both the E0 control engine and E15 test engine ran leaner at idle and low speed at the end of the endurance test. When operated on E15 fuel after 300 hours of endurance, the lean operation at idle coupled with the additional enleanment from the E15 fuel caused the engine to exhibit misfire and poor run quality (intermittent misfire or partial combustion events). A misfiring engine would cause customer dissatisfaction due to the inability to idle the engine properly, excessive shaking, and hesitation or possibly stalling upon acceleration. As it relates to this study, the misfire caused an increase in HC emissions at idle. This increase in HC variability at idle caused the average total HC+NOx to increase from the start to end of endurance, whereas the HC+NOx on E0 fuel on both engines showed a decreasing trend. As expected, the CO emissions were reduced when using E15 fuel due to the leaner operation.

The power and torque output of the E15 engine was higher with E15 fuel than with E0 fuel. The power and torque output of the E0 control engine increased slightly with more endurance time. The power and torque output of the E15 test engine showed a flat or declining trend with more endurance time.

The end of test inspection showed evidence of elevated temperatures on base engine components due to the lean running on E15 fuel. There were significantly more carbon deposits on several components of the E15 engine, indicating that these parts likely had higher metal temperatures during operation. Hardness measurements indicated that the pistons had higher operating temperatures on the E15 engine. The exhaust gas temperature increased 17°C at wide open throttle as a result of the leaner operation on E15 fuel.

The fuel pump gasket on the E15 engine also showed signs of deterioration compared with the E0 engine after approximately 2 months of exposure to E15 fuel.

300HP Four-Stroke Supercharged Verado:

The E15 Verado failed 3 exhaust valves prior to completion of the endurance test. One valve completely failed and 2 others had developed significant cracks. Metallurgical analysis showed that the valves developed high cycle fatigue cracks due to excessive metal temperatures. The majority of exhaust valves on the E15 engine lost a significant amount of lash which may have contributed to the observed valve failures. The exhaust gas temperature increased 25-30°C at wide open throttle due to the lean operation with E15 fuel.

In addition to the elevated temperatures on the exhaust valves, the pistons showed evidence of higher operating temperatures. The carbon deposit differences indicated that the E15 engine's pistons were hotter during operation.

The E15 Verado generated HC+NOx values in excess of the Family Emissions Limit when operated on E15 fuel, but did not exceed the limit when operated on EEE-E0. The primary contributor to the increase in exhaust emissions was the NOx due to enleanment caused by the oxygenated fuel. The CO emissions were reduced when using E15 fuel due to the leaner operation, as expected.

At emissions mode point 3, the lean combustion due to the E15 fuel caused the engine to lose torque output due to operation significantly leaner than LBT. As a result of the torque loss, the throttle input had to be increased 10% to maintain the same torque output as on E0-EEE fuel. The change in throttle input caused an increase in fuel flow of 10%. Mode 3 is representative of a typical cruising speed and load. The E15 fuel would cause the fuel consumption to be 10% higher at that operating point for a customer.

200HP EFI 2.5L Two-Stroke:

The 200HP EFI two-stroke engine showed no signs of exhaust emissions deterioration, though the emissions output after the full endurance testing was not measured due to a failure of the E15 engine. The primary driver of the HC+NOx emissions on this engine family was HC (approximately 98% of the HC+NOx total). As expected, since the E15 fuel caused the engine to run lean, the HC emissions were lower, as were the CO emissions. There was more variability of HC+NOx observed on the E0 engine than the change in emissions on the E15 engine. The deterioration of the CO emissions had similar trends between the 2 engines.

The endurance test of the E15 engine was stopped short of the 300 hour target due to a connecting rod bearing failure on cylinder 3. The root cause of the bearing failure could not be identified. More testing is necessary to understand the effects of ethanol on two-stroke engine lubrication mechanisms where the oil and fuel move together through the crankcase. The E0 engine completed the entire 300 hours of durability testing.

Other than the bearing failure, the end of test teardown and inspection did not show any visible significant difference between the 2 engines. Hardness checks performed on the pistons of both engines indicate that the E15 engine may have had higher piston temperatures, a concern on two-stroke engines where higher temperatures could lead to more power cylinder failures. The exhaust gas temperature increased 15-20°C on average due to the lean operation with E15 fuel.

4.3L V6 EFI Four-Stroke Catalyzed Sterndrive

Since E15 fuel was readily available in the test facility and an engine equipped with exhaust catalysts was on the dynamometer, emissions tests were conducted on a 4.3L V6 sterndrive engine. No durability testing was performed. At rated speed and wide open throttle the exhaust gas temperatures increased by 20°C on average and the catalyst temperatures increased by 30°C. This increase in catalyst temperature would likely cause more rapid aging and deterioration of the catalyst system at WOT. The overall effect of the increase in deterioration rate would be duty cycle dependent. The HC and CO values decreased at the Mode 1 (rated speed, rated power) emissions test point, which is an open loop operating point, due to leaner operation with E15 fuel, as expected. The fuel consumption increased by 4.5% at the operating points that were running in closed-loop fuel control.

Recommendations:

This test program was limited in scope in terms of operating conditions. More investigation is necessary to understand the effects over a broader range of conditions. Ethanol's effects on part load operation, cold start, hot restart/vapor lock, and overall driveability need to be evaluated. The wide range of technology available for marine engines due to the wide range of engine size will complicate this issue significantly. Mercury Marine produces engines from 2.5HP-1350HP with a wide array of technologies ranging from two-stroke or four-stroke; carbureted, EFI, or direct fuel injected; naturally aspirated, supercharged, or turbocharged; and more.

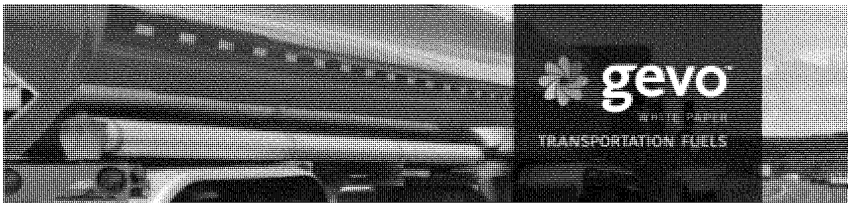
Ethanol's ability to absorb water into the fuel is of paramount concern for the marine market and this issue has not been addressed in this test program. The contaminants that water can bring with it, potentially saltwater, can cause severe corrosion in fuel systems. A leak or fuel system failure could cause the engine to be inoperable and leave the vessel stranded, which would obviously be a major dissatisfaction to the customer. In addition, a better understanding of the effects higher ethanol blends have on marine fuel systems in terms of materials compatibility and corrosion is needed. Marine vessels tend to have very long storage durations, can be stored in very humid environments, and will have more opportunities to have fuel system exposure to water, including saltwater.

More testing is needed to understand how ethanol blends affect oil dispersion in two-stroke engines that have fuel and oil moving through the crankcase together. Ethanol tends to be a good solvent and may break down lubrication at critical interfaces by cleansing these surfaces of the residual oil film.

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GEVO WHITE PAPER FROM THE TESTIMONY OF MR. JACK HUTTNER, EXECUTIVE VICE PRESIDENT, COMMERCIAL AND PUBLIC AFFAIRS, GEVO, INCORPORATED



Renewable Solution

ISOBUTANOL—A RENEWABLE SOLUTION FOR THE TRANSPORTATION FUELS VALUE CHAIN

Executive Summary

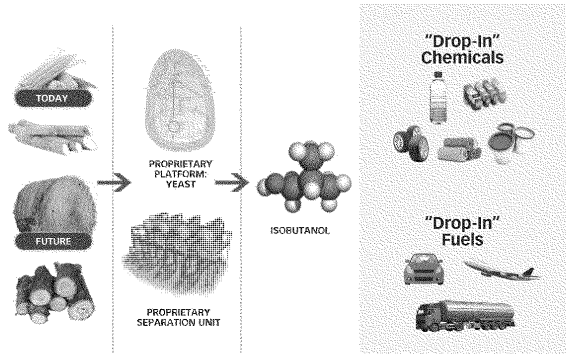
The demand for a clean, renewable biofuel increases as new benchmarks are legislated and increased pressure is placed on the petroleum industry to reduce America's dependence on imported fossil fuels for energy consumption.

Gevo®—a leader in next-generation biofuels—has developed and patented a cost-effective process, Gevo Integrated Fermentation Technology® (GIFT®), which converts fermentable sugars from sustainable feedstocks into isobutanol, a biobutanol product that provides solutions to many of the value chain issues highlighted by first-generation biofuels.

In this paper, you'll learn how isobutanol provides a renewable solution to improve the transportation fuels value chain.

What You Will Learn:

» Isobutanol is a dynamic platform molecule.
» Isobutanol ships in pipeline systems.
» Isobutanol can address future regulatory issues now.
» Isobutanol mitigates end-user challenges.



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As the demand for renewable sources of fuels intensifies, it is imperative that the transportation fuels industry has the necessary solutions to optimize the value chain. Gevo's renewable isobutanol can potentially be applied across the entire transportation fuels industry and shipped through the pipeline, while complying with government regulations and mitigating end user issues.

To find out how isobutanol is the next-generation biofuel, contact us at:

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Certain statements in this document, including, without limitation, Gevo's ability to produce cellulosic isobutanol once biomass conversion technology is commercially available, may constitute "forward-looking statements" within the meaning of the Private Securities Litigation Reform Act of 1995. These forward-looking statements are made on the basis of the current beliefs, expectations and assumptions of the management of Gevo and are subject to significant risks and uncertainty. Investors are cautioned not to place undue reliance on any such forward-looking statements. All such forward-looking statements speak only as of the date they are made, and the Company undertakes no obligation to update or revise those statements, whether as a result of new information, future events or otherwise. For a further discussion of risks and uncertainties that could cause actual results to differ from those expressed in these forward-looking statements, as well as risks relating to the business of Gevo in general, see the risk disclosures under the section captioned "Risk Factors" in Gevo's final prospectus related to its initial public offering filed pursuant to Rule 424(b) under the Securities Act of 1933, as amended on February 9, 2011.

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TABLE OF CONTENTS

Background on Butanol 1

Isobutanol—A Renewable Solution 1

Isobutanol Is a Dynamic Platform Molecule 3
- Gasoline and Renewables 3
  - Isobutanol Can Also Be Converted to Jet 6
  - IPK/Kerosene 6

Isobutanol Can Use the Existing Pipeline Distribution Infrastructure 7
- Integrity 8
- Quality 8
- Operations 8

Isobutanol Can Address Future Regulatory Issues Now 9
- RIN Volume/Generation 9
- "Advanced" RIN Capable 9
- One PSI Waiver 10
- Ozone Control 11

Isobutanol Mitigates End-User Issues 12
- Certification Concerns 12
- Consumer Labeling/Product Liability Concerns 12
- Operational Concerns 12
- Price and Energy Content Concerns 13
- Marine and Small-Engine Concerns 13
- Summary 13

The Authors 14

Butanol Evolves

BACKGROUND ON BUTANOL

The use of butanols in gasoline goes back to the 1970s–'80s and has been approved under Section 211(f) of the Clean Air Act through the "Arconol," "DuPont" and "Octamix" waivers. At that time, tert-butyl-alcohol (TBA), a man-made material, was the prime butanol used, although research suggests that isobutanol was also being evaluated. These butanols were produced from petroleum processes: Both n-butanol and isobutanol were produced using the oxo process, and TBA was a by-product of the PO process.

Gevo has developed a proprietary biochemical pathway to produce renewable isobutanol, a four-carbon alcohol with many attributes that may aid the transportation fuels industry across its value chain. It is now being evaluated as a next-generation biofuel.

Isobutanol should not be confused with the other isomers in the butanol family (n-butanol, sec-butanol, tert-butyl-alcohol [TBA]). It is a naturally occurring material with a musky odor found in many essential oils, foods and beverages (brandy, cider, gin, coffee, cherries, raspberries, blackberries, grapes, apples, hop oil, bread and Cheddar cheese).

Today, Gevo has developed a renewable method to produce a 98+ percent–purity product using sugars from any available source. The initial plan is to convert existing U.S. cornstarch ethanol plants into isobutanol plants for a fraction of the cost to build new facilities. Gevo also plans to upgrade some of these facilities to produce an isobutanol that will be classified as an advanced biofuel as defined by EPA under the U.S. Energy Independence and Security Act (EISA), to allow cellulosic sugars to be used as a feedstock as they become cost competitive, and to allow multiple products to be generated.

ISOBUTANOL IS A NEXT-GENERATION RENEWABLE FUEL AND A "BUILDING BLOCK" TO THE FUTURE FUELS VALUE CHAIN

To become a next-generation renewable fuel, it is paramount that the manufacture of a renewable product leverages existing infrastructure and extends the current fuels value chain. With the U.S. oil-and-gas downstream industry (inbound distribution, refining, outbound distribution and marketing) conservatively valued at over $500 billion, it would be inefficient to build an entirely new supply chain infrastructure to accommodate a renewable product industry valued at less than 10 percent of the downstream industry.

The optimal value chain for a transportation fuel, including renewables, might look like this [Figure 1]:

Figure 1



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Feedstocks are shipped to a producer (refiner, blender or bio-refiner), where they are converted to a finished product, which is then cost-effectively shipped to market, and sold to the end user based on a specification that meets regulatory needs. Over time, as regulations have been introduced, the optimal value chain has remained intact.

With the advent of the Renewable Fuel Standard (RFS) and EISA, the value chain, using first-generation renewable products, has been changed; for example, ethanol enters the value chain at the terminal (Figure 1a), where it is either blended with a sub-octane gasoline product to produce the finished gasoline, or is added to a finished gasoline to produce a higher-octane product.

Figure 1a

Existing Gasoline Value Chain

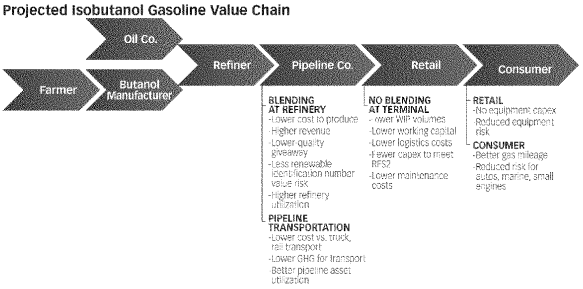


This inefficiency primarily stems from the inability of first-generation biofuels to be shipped in a pipeline, adding system cost(s) as additional capital is required at the terminals for blending these products. Additionally, giveaway costs increase as refiners no longer ship finished products but are held legally accountable for the finished-product specification. If the trend toward using first-generation biofuels grows, pipeline throughput volumes may decrease, giving rise to potential tariff increases on the remaining shippable products.

By analogy, isobutanol is today's "smartphone" to first-generation biofuels' "cell phone;" it can re-optimize the value chain with its ability to be shipped in pipelines, both inbound to and outbound from a refining/blending facility, as shown in Figure 1b. The versatility of isobutanol's properties as a blendstock for gasoline and its ability to be converted to other valuable products give the downstream industry great flexibility.

Figure 1b

Projected Isobutanol Gasoline Value Chain



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Dynamic Molecule

ISOBUTANOL IS A DYNAMIC PLATFORM MOLECULE

Isobutanol is an ideal platform molecule, a more flexible and versatile renewable alternative to current biofuels. It can be used as a "drop in" gasoline blendstock; it converts readily to isobutylene, a precursor to a variety of transportation fuel products such as iso-octene (gasoline blendstock), iso-octane (alkylate—high-quality gasoline blendstock and/or avgas blendstock), iso-paraffinic kerosene (IPK, or renewable jet) and diesel. Isobutanol is not constrained to just the gasoline pool; hence, its value to a producer and/or purchaser is its flexibility.

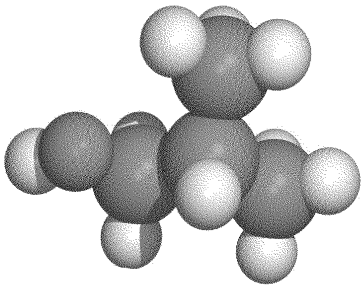
Gasoline and Renewables

The oil embargoes of the 1970s drove the introduction of alternative, renewable feedstocks for the oil-and-gas industry. At the time, the EPA granted various waivers allowing methanol, ethanol, butanols and other materials into gasoline. By the 1990s, the Clean Air Act required gasoline to have an oxygenate added to improve urban air quality. Until 2005, there were two primary options: MTBE (produced by the refinery and optimally blended into the finished product) and ethanol (produced locally and blended into gasoline, not always optimally, at various distribution terminals).

With the creation of the Renewable Fuel Standard (RFS) and the elimination of MTBE as a viable blendstock in 2004, ethanol became the prime renewable material. Production increased dramatically. As more ethanol entered the market, its price decreased relative to gasoline and its usage increased. The 2007 Energy Independence and Security Act (EISA), which requires different categories of renewable fuels (based on greenhouse gas emission reductions), has also increased the volume obligation of a refiner or blender to use renewable products. In addition, as sulfur and benzene concentrations in gasoline have been addressed, it is anticipated that there will be continued efforts to lower ozone levels, with gasoline volatility being a key driver.

The first-generation renewable products have provided a good start to improving air quality and increasing energy independence, but may not provide an optimal economic solution across the value chain. Isobutanol, as the next-generation product, builds on the foundation and provides additional solutions to various challenges not met by first-generation products. Some of these include:

» Blend properties in gasoline
» Volatility
» Phase separation
» Energy content
» Blend wall



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Blend Properties in Gasoline

Isobutanol has several blend property advantages: low Reid Vapor Pressure (RVP), above-average octane, good energy content, low water solubility and low oxygen content (Figure 2).

Figure 2

	ETHANOL	ISOBUTANOL
Blend RVP	18–22 psi	4.5–5.5 psi
Blend Octane	112	102
Energy Content (% of gasoline)	65%	82%
Water Solubility	Fully Miscible (100%)	Limited Miscibility (8.5%)
Oxygen Content	35%	22%

Volatility

As sulfur and benzene content in gasoline is limited by legislation, it is likely that efforts to control ozone, which have already increased, will continue to increase in the future.

A key tool used by state regulatory agencies for reducing ozone precursors in the air is through reduced volatility of gasoline as measured by RVP. As ethanol's RVP blend value is high (~18 psi for E10 blends), the base blendstock for oxygenated blending (BOB) must be low to accommodate this high-RVP material. This problem will be exacerbated as any ethanol blends less than 9 percent or greater than 10 percent currently do not qualify for a 1-psi waiver.

Isobutanol's low-blend value RVP (~5.0 psi for 12.5 percent–volume blends) (Figure 3) allows refiners to decrease costs by optimally blending additional lower-cost blendstocks (butane, pentane, NGLs, naphtha) and/or reducing the purchases of more costly low-RVP alkylate. For example, by using Baker and O'Brien's proprietary PRISM™ model (Figure 4) , a refinery serving a low-RVP gasoline market was able to eliminate alkylate purchases and significantly increase butane purchases by using isobutanol instead of ethanol.

Figure 3

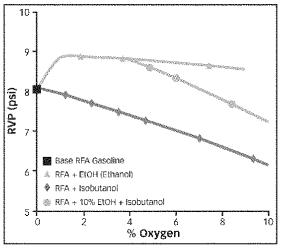
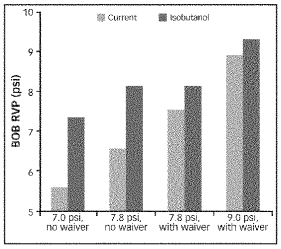


Figure 4

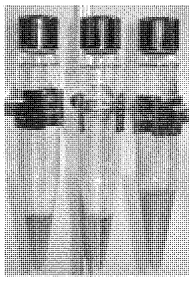


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Phase Separation

Because gasoline may come in contact with water, it is important that the blendstocks remain in the hydrocarbon phase and not migrate into the water. Ethanol, a highly polar material, will separate from the gasoline phase into the water phase, degrading the gasoline's octane. Isobutanol is less polar than ethanol, and tends to act like a hydrocarbon with very limited amounts moving from the gasoline phase to the water phase [Figure 5]. As a result, there is no dilution of the gasoline's octane value, and operational issues related to water content are reduced or eliminated.

Figure 5



Gasoline with 10% Water | Isobutanol-Blended Gasoline with 10% Water | Ethanol-Blended Gasoline with 10% Water

Energy Content

Isobutanol has approximately 82 percent of the energy value of gasoline. Although every engine is different, higher energy content typically translates into greater fuel economy. In addition, per EISA, as isobutanol has 30 percent more energy than ethanol, its equivalence value (EV) is 1.3 [Figure 6], which translates into significantly more renewable identification numbers (RINs) being generated than ethanol.

Figure 6

BIOFUEL	EQUIVALENCE VALUE (EV)
Ethanol	1.0
Isobutanol	1.3
Biodiesel (FAME)	1.5
Renewable Jet (Biojet, IPK)	1.6*
Renewable Diesel	1.7

*Estimate based on EISA formula.

Blend Wall

Engine manufacturers are concerned about exceeding 3.5 percent–by-weight oxygen levels, and obligated parties need to generate even greater RINs. Isobutanol provides a solution to these needs. If isobutanol were used at E10 oxygen content levels (3.5 percent–by-weight oxygen), it would generate more than twice the RINs. Even at transitional "substantially similar" oxygen levels (2.7 percent– by-weight oxygen), isobutanol generates more RINs than either E10 or E15 [Figure 7].

Figure 7

	OXYGEN CONTENT (%)	EV	RINS GENERATED PER 100 GALLONS FINISHED PRODUCT
12.5% Isobutanol	2.7	1.3	16.25
10% Ethanol	3.5	1.0	10.00
16.1% Isobutanol	3.5	1.3	20.93
15% Ethanol	5.2	1.0	15.00

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Converting to Jet Fuel

ISOBUTANOL CAN ALSO BE CONVERTED TO PRODUCE A RENEWABLE JET

According to the International Civil Aviation Organization (ICAO), environmental efficiency gains from technological and operational measures may not offset the overall emissions that are forecast to be generated by the expected growth in air traffic. As a result, the airline industry is evaluating sustainable alternative fuels to reduce its greenhouse gas (GHG) emissions profile, while improving local air quality. It is the ICAO's view that the development and use of sustainable alternative fuels may play an active role in improving the overall resource allocation and security of aviation fuels supply, perhaps by stabilizing fuel prices. A global framework has been established for sharing information on best practices and/or initiatives to allow sustainable alternative aviation fuels to be developed and brought to market.

IPK/KEROSENE

Isobutanol is an ideal platform molecule to produce renewable iso-paraffinic kerosene (IPK), a blendstock for jet fuel. Through known technology, isobutanol can be readily converted to a mix of predominantly C12/C16 hydrocarbons [Figure 8].

Figure 8

Bio-based IPK Jet



Gevo's IPK offers several benefits:

» **Blend Rate**—may be blended at up to a 1:1 ratio with petroleum jet.

» **Properties**—very low freeze point (–80°C), high thermal oxidation stability, and meets ASTM distillation curve requirements.

» **Regulatory**—using EISA's formula, the projected EV is approximately 1.6, which, at a blend rate of 50 percent, would generate 80 RINs per 100 gallons of finished product.

» **Tax Credit**—it qualifies for a $1.00/gallon tax credit under IRS Title 26, Subtitle A, Chapter 1, Subchapter A, Part IV, Subpart D, Article 40A.f.3.

» **GHG**—using renewable energy and/or improved feedstocks in the production process, it has the potential to significantly reduce GHG emissions.

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Distribution Versatility

ISOBUTANOL CAN USE THE EXISTING PIPELINE DISTRIBUTION INFRASTRUCTURE

A key advantage for isobutanol to be adopted into the transportation fuels industry is its ability to be shipped in pipelines without negatively affecting the integrity, quality or operations of the pipeline system [Figure 9, below].

Pipelines are a key part of the value chain, and using the existing infrastructure to move product may provide significant advantages:

» There is value in blending at the refinery instead of at the terminal. According to a Solomon Associates presentation* finished fuel from a refinery appears to avoid giveaway costs estimated at $0.01 to $0.03 per gallon of finished gasoline.

» As ethanol volumes have grown, pipeline throughputs have fallen; with lower throughputs, tariffs on the remaining products may increase.

» Shipping material by pipeline is the most cost-effective manner to move liquid products compared to rail, barge and/or truck.

Isobutanol has the potential to be used in the existing pipeline system, both inbound and outbound, providing potential cost savings, flexibility and efficient access to end-user markets.

Figure 9

	ETHANOL		ISOBUTANOL	
Integrity				
Stress Corrosion Cracking	Yes		No	
Elastomeric Compatibility	Manageable		Highly Compatible	
Quality				
Oxygen Content in Gasoline	E10 E15	3.5% 5.2%	IB2.5 IB4.1	2.7% 3.5%
Ship Neat Product	Qualified No		Qualified Yes	
Operations				
Blend Location	Terminal		Refinery/Terminal	
Segregated Storage	Yes		No	

*Use of Ethanol in Conventional Gasoline Blending—A Look at U.S. Refiner Trends by John Popielarczyk, October 2009, NPRA Q&A meeting.

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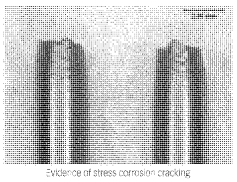
Integrity

There are two key measures of integrity:

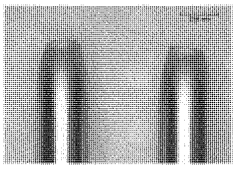
» Stress corrosion cracking (SCC)

» Elastomeric compatibility issues

Det Norske Veritas (DNV), a leading corrosion consultantcy that has done significant work on the distribution of ethanol-blended gasoline, has also evaluated isobutanol. Based on DNV's conclusions, carbon steel is susceptible to stress corrosion cracking (SCC) in fuel-grade ethanol; however, no SCC was noted in isobutanol-containing gasoline at concentrations of 12.5 percent and 50 percent, nor was any SCC found with neat isobutanol, as shown at right. In addition, several elastomeric materials were evaluated with respect to their compatibility with isobutanol and gasoline; the tested materials showed better performance in isobutanol than in gasoline.



Evidence of stress corrosion cracking



No stress corrosion cracking at 12.5% isobutanol

Quality

Today, regulatory pathways exist for isobutanol to be used in gasoline at two volume levels, 12.5 percent under the EPA "substantially similar" ruling (2.7 percent by-weight oxygen content) and 16.1 percent under previous EPA waivers (DuPont, Octamix waivers allowing 3.5 percent by-weight oxygen content). Discussions with pipeline distribution companies have revolved around the shipping, handling and storage of three possible products: 12.5 percent and 16.1 percent by-volume isobutanol-containing gasoline and 100 percent neat isobutanol.

Operations

In recent years, many terminals have increased capital spending to handle blending of ethanol. At the same time, the volume throughput of pipelines has been reduced by the amount of ethanol blended at the terminal. Isobutanol, shipped to a refinery, optimally blended to reduce giveaway cost(s), and then shipped as a finished product to end-user markets, would use the existing assets more cost-effectively.

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Regulations and RIN

ISOBUTANOL CAN ADDRESS FUTURE REGULATORY ISSUES NOW

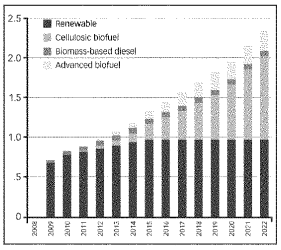
A key driver for isobutanol that will influence its adoption into the transportation fuels industry is the impact that existing and potential regulations may have on guiding which renewable fuels become prominent. Key issues include total RIN volume needed, RIN generation, type of RIN generated, 1 psi waiver and ozone control.

RIN Volume/Generation

EISA (or RFS2) set new volume targets for the industry; specifically, by 2022, 36 billion gallons per year (or about 2.4 million barrels per day) of renewable products are to be used [Figure 10]. To account for this volume, a renewable identification number (RIN) was established; using the concept of equivalence value (EV) [Figure 6, p. 5], which allows a multiplier based on energy content to be used, it is conceivable that the physical volume used by the transportation fuels industry is less than the EISA target volumes. For example, in Figure 11 (below), if 10 gallons of ethanol with an EV of 1.0 are used, 10 RINs are generated per 100 gallons of finished product. With isobutanol, if 12.5 gallons are used with an EV of 1.3, 16.25 RINs are generated per 100 gallons of finished product. The RINs generated are a function of the physical volume used multiplied by the EV of the renewable product.

Figure 10

TARGET VOLUME
(mmbl/day)

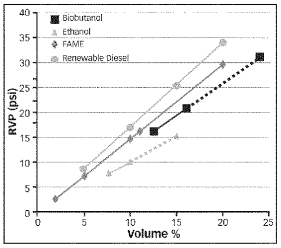


"Advanced" RIN Capable

A key component of the EISA legislation was the introduction of RIN types: renewable and advanced. The advanced category, with a minimum hurdle of reducing GHG emissions by 50 percent, has the subsets of cellulosic, biomass-based diesel and "advanced other." The ultimate volume requirement for the renewable type was set at 15 billion gallons per year (BGY), and for the advanced type at 21 BGY. Although target volumes were set for the cellulosic and biomass-based diesel categories, EPA has the authority to adjust these totals annually, based on availability, but it cannot reduce the total advanced requirement. As such, there may be a growing need [Figures 12, 13, p. 10] for products that meet the "advanced other" category, or products that have 50 percent lower greenhouse gas emissions compared to gasoline.

Figure 11

RINS GENERATED
(per 100 gallons of Finished Product)



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One psi Waiver

Another key driver of isobutanol adoption is a consistent standard with regard to volatility; for E10 blends, ethanol was granted a 1 psi waiver when the finished-product RVP was considered. If a state implementation plan (SIP) required a 9.0 psi RVP for conventional gasoline, this specification would become 10 psi when using ethanol blends.

At present, only gasoline blends containing 9 percent to 10 percent ethanol are granted a 1 psi waiver. Hence, finished product with a 9.0 psi must have a base blendstock RVP substantially lower than 9.0 in order to accept higher ethanol blends, i.e., E15+.

With isobutanol, obligated parties have considerably greater formulation flexibility and might be able to go as high as 9.6 psi in their blendstock and still meet their Clean Air Act requirements without a waiver.

Figure 12

PROJECTED RIN (Gallons)
VERSUS EISA NEEDS (mmbl/day)

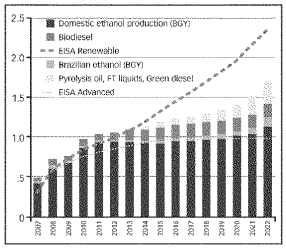
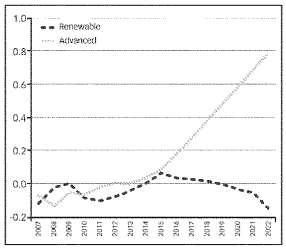


Figure 13

PROJECTED UNDER-SUPPLY
(mmbl/day)



NOTE: Per EISA, corn starch derived ethanol plants are excluded from achieving an "advanced biofuel" level. However, starch derived isobutanol plants have the ability to achieve the advanced status. As the only currently available advanced products are FAME biodiesel (limited volumes) and Brazilian ethanol imports, isobutanol provides a secure alternative to meet this need.

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Ozone Control

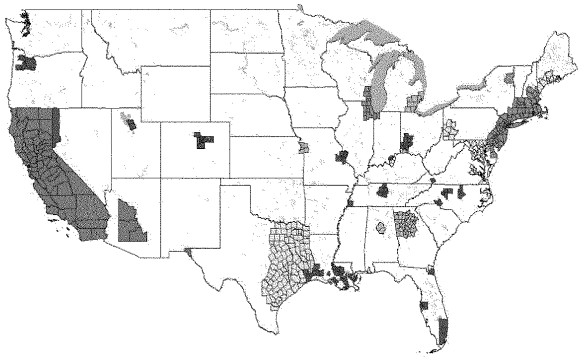
Ground-level ozone is harmful to breathe and damages crops, trees and other vegetation. Gasoline volatility is the key lever used by the states to control ozone precursors. There are already many markets requiring special RVP specifications (Figure 14). If the EPA target for ozone is set at 75 ppb, it is estimated that over 300 counties nationwide will fall out of compliance. In addition, a U.S. EPA Scientific Advisory Board (SAB) has recommended that the ozone target be lowered (perhaps to 60–70 ppb), which would have a dramatic impact on most of the U.S. gasoline market. Isobutanol, with its low-blend volatility, provides obligated parties greater flexibility to meet both lower volatility (RVP) and renewable fuel obligations.

Figure 14

Market RVP Specification	Gasoline Market Size	Isobutanol Market Opportunity
PSI	BGPY	BGPY
7.0 no waiver[1]	18	2.2
7.8 no waiver	16	1.9
9.0 no waiver	18	2.2
7.0 waiver	6	0.7
7.8 waiver	11	1.3
9.0 waiver	72	8.6

Increasing value

[1]Waiver – 1 psi RVP waiver given to ethanol in many markets



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Overcoming Concerns

ISOBUTANOL MITIGATES END-USER ISSUES

The concept of energy independence was established with the introduction of first-generation renewable fuels. However, in trying to increase the use of these products, several significant constraints must be addressed relative to the various end users: certification of storage tank/dispensing equipment, equipment operational concerns, product liability issues for convenience store operators, fuel mileage/maintenance issues and American pride/innovation. Isobutanol can address these concerns as the next step in the evolution of American-produced biofuels.

Fuel Dispenser Certification Concerns

Underwriters Laboratories (UL) establishes the safety requirements and testing procedures for automotive fuel dispenser systems (UL 87) and certifies new products to ensure they meet material compatibility, adhere to fire safety codes, and are consistent with related products. Although UL has certified certain dispensers for ethanol volumes greater than 10 percent, most existing dispensers used by convenience store operators were only tested and approved for 10 percent blends. The cost of replacing the dispensers is uneconomical for the operator. Isobutanol's initial use would be at EPA gasoline "substantially similar" levels eliminating the need to replace or certify fuel dispensers.

Consumer Labeling/Product Liability Concerns

EPA has given qualified approval for the sale of E15 blends for use in car model years 2001 and newer, and discussions are under way to determine an appropriate label to be displayed on the dispenser to ensure that the consumer uses the appropriate fuel for their car. Unfortunately, per EISA and its current legal framework, the liability to ensure that the consumer uses the right fuel is placed on the convenience store operator. Many operators find this risk to be too high to consider selling ethanol blends above 10 percent. Again, as isobutanol's initial use would be at EPA "substantially similar" levels, it would be considered the same as a conventional petroleum product.

Operational Concerns

The use of ethanol in gasoline has been encumbered by operational issues. In addition to its phase separation issues, it is a fairly strong solvent that tends to dislodge dirt/sludge from the dispensing equipment, causing dispenser filter problems and gasket leaking. Isobutanol is not as potent a solvent as ethanol, and based on preliminary discussions with dispenser equipment suppliers, is not expected to have the same issues as ethanol.

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Price and Energy Content Concerns

Consumers tell us that although price remains a key driver of fuel purchase decisions, product performance as a reason for choosing a gasoline brand is increasing. Consumers are keeping their vehicles longer and taking better care of them; rethinking what goes in the tank is becoming more important. Any product that reduces fuel mileage and/or may increase maintenance costs will be avoided if there is a better alternative. Isobutanol has higher energy density than ethanol, and tests are being conducted to quantify this potential benefit to fleet operators and the general motoring public. Qualitatively, gasoline marketers are looking for ways to differentiate themselves, and having a fuel that is renewable but not ethanol is of high interest.

Marine and Small-Engine Concerns

For specialized uses, such as small-engine and/or marine fleet engines, it is paramount to have a fuel that does not cause operational safety issues and can meet EPA emission targets. As the amount of oxygen content in a fuel increases, the operating temperature of that engine increases, potentially causing undue wear and increased emissions. This is an issue with engines that do not have sophisticated instrumentation. In addition, safety issues have been highlighted, relative to higher idle speeds and unintentional clutch engagement.

The National Marine Manufacturers Association (NMMA), the Outdoor Power Equipment Institute (OPEI) and many of their member companies are evaluating isobutanol as a possible alternative to ethanol to help reduce emissions and eliminate phase separation issues. For example, BRP US Inc. recently conducted a study that found butanol-containing gasoline produced less greenhouse gas emissions and had less engine enleanment than ethanol-blended gasoline.

Summary

The petroleum industry needs to focus on innovation to meet future environmental regulations, achieve energy independence and mitigate end-user issues. Isobutanol is an ideal platform molecule to address these issues while benefiting the transportation fuels industry value chain.

Isobutanol may provide environmentally favorable options for the transportation fuels industry to position its products facilities and manufacturing processes to meet increasingly stringent regulatory policies and industry standards.

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Dr. Christopher Ryan is the executive vice president of business development at Gevo. He started his tenure at Gevo in 2009 with more than 15 years of strategic leadership, business development, and research and product development in bio-based materials. Most recently, Dr. Ryan was chief operating officer and chief technology officer for NatureWorks, LLC, which he cofounded in 1997. While at NatureWorks, Dr. Ryan was involved in the development and commercialization of the company's new bio-based polymer from lab-scale production through the introduction and growth of PLA through its $300 million world-scale production facility. He also spent four years working in corporate R&D for HB Fuller, a specialty chemicals company.

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Mr. Bevers is a member of and actively participates on numerous industry organizations and committees: API/PIDX, SIGMA, NACS/PCATS, PMAA, ILTA, NPECA and MPGA.

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POTENTIAL SUPPLY AND COST IMPACTS OF LOWER SULFUR, LOWER RVP GASOLINE, PREPARED FOR THE AMERICAN PETROLEUM INSTITUTE, JULY 2011, BY BAKER AND O'BRIEN INCORPORATED

POTENTIAL SUPPLY AND COST IMPACTS OF LOWER SULFUR, LOWER RVP GASOLINE

PREPARED FOR THE AMERICAN PETROLEUM INSTITUTE JULY 2011

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Kevin P. Milburn
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TABLE OF CONTENTS

I. ABSTRACT 1

II. INTRODUCTION 3

III. EXECUTIVE SUMMARY 5

REGULATORY ASSUMPTIONS 8
TECHNOLOGY AND INVESTMENT COSTS 9
ANALYTICAL BASIS 10
STUDY RESULTS 11

IV. REGULATORY ASSUMPTIONS 17

GREENHOUSE GAS EMISSIONS 20
OTHER REGULATIONS 20

V. GASOLINE CONSUMPTION FORECAST 21

VI. TECHNOLOGY AND CAPITAL INVESTMENT COSTS 22

FRACTIONATION 22
FCC FEED AND GASOLINE DESULFURIZATION 22
CAPITAL COSTS FOR GRASSROOTS UNITS 23
REVAMP/EXPANSION COSTS 24
NATURAL GAS LIQUID (NGL) STORAGE AND LOADING COSTS 24
OTHER OFF-SITE CAPITAL COSTS 25
CONTINGENCY ALLOWANCE 25
CAPITAL INVESTMENT CHARGE 25

VII. INPUT COSTS 26

NATURAL GAS COST 26
HYDROGEN COSTS 26

VIII. ANALYTICAL BASIS 27

REFINERY MODELING 27
REFINERY CAPACITY AND UTILIZATION 28
CRUDE SLATE 29
SEASONALITY 29
CALIFORNIA REFINERIES 30
DISPOSITION OF EXCESS NGLS 30

REDUCE NGL IMPORTS 30
DISPLACE OTHER ETHYLENE CRACKER FEEDSTOCKS 30
EXPORT MARKETS 32
CONSUME OR SELL AS FUEL OR HYDROGEN FEEDSTOCK 33
ALKYLATION 33
STOCKPILE FOR WINTER CONSUMPTION 33
NGLS TRANSPORTATION 34
VALUATION OF EXCESS NGLS 35
COMPLIANCE RESPONSE 36
OTHER GASOLINE SUPPLY 38
IMPORTS 38
ETHANOL QUALITY 38

IX. STUDY RESULTS 39

BASE CASE GASOLINE SUPPLY BALANCE AND REFINERY OPERATIONS 39
COMPLIANCE RESPONSE 40
STUDY AND SENSITIVITY CASES GASOLINE SUPPLY BALANCE AND REFINERY OPERATIONS 42
DISPOSITION OF SURPLUS NGLS 44
GREENHOUSE GAS EMISSIONS 48
TOTAL COMPLIANCE COSTS 49
COMPARISON TO AAM REPORT 51

X. CONCLUSIONS 53

I. ABSTRACT

A proposal has been made by the Alliance of Automobile Manufacturers for a single national (excluding California) summertime gasoline specification that they referred to as National Clean Gasoline (NCG). NCG, as proposed, would require significantly lower sulfur limits than current United States gasoline and, for much of the nation, also significantly lower limits on Reid vapor pressure (RVP).

This report examines four potential scenarios with lower sulfur and lower RVP requirements than current gasoline specifications. In two, summertime RVP is reduced nationwide (excluding California) to 7 pounds per square inch absolute (psia). In the other two, summer time RVP's are limited to 7.8 psia and 8.8 psia (including a 1 psia waiver for ethanol blending) in regions that currently allow the waiver for conventional gasoline. Reformulated gasoline (RFG) maintains an RVP of 7.0 psia. In three of the cases, sulfur in individual batches is limited to 20 parts per million (ppm) with a company annual average limit of 10 ppm. In one case, the sulfur limits are 10 and 5 ppm, respectively.

The results of the analysis show that four to seven refineries are likely to shut down rather than make the necessary investments to produce gasoline with lower sulfur and lower RVP specifications. A substantial volume of domestically-produced light hydrocarbon currently blended into gasoline would be removed from gasoline and would be sold into other markets. Total domestically-produced gasoline (excluding ethanol) is estimated to decrease by 0.6 to 1.3 million barrels per day during the summer. If gasoline consumption remains at Base Case levels, gasoline imports would more than double in three of the cases, leaving the U.S. more exposed to supply disruptions. Annualized marginal compliance costs for U.S. refineries are estimated in the range of 12 to 25 cents per gallon. Summer-only costs are nearly double that of annualized costs. Additional hydrotreating and fractionation required to comply would result in an

increase in carbon dioxide (CO_2) emission from refineries that continue to operate. On an annual average basis, the total increase in CO_2 emissions at domestic and foreign refineries is estimated at 2.9 to 7.4 million tonnes per year.

II. INTRODUCTION

In 2009, the Alliance of Automobile Manufacturers published a report[1] (the AAM Report) documenting purported costs and benefits of a single national standard for gasoline quality that would apply to all states except California. The AAM Report calls the new gasoline standard "National Clean Gasoline." The American Petroleum Institute (API) engaged Baker and O'Brien, Inc. (Baker & O'Brien) to perform an independent analysis to determine the potential supply and cost impacts of lowering the specifications for sulfur and RVP in gasoline. This study was prepared by Baker and O'Brien using its own models and analysis.

General industry conditions, corporate profiles, geographic considerations, and unique refinery characteristics can influence potential responses to regulatory requirements. Therefore, Baker & O'Brien undertook a refinery-by-refinery approach in evaluating the potential impacts of lowering the specifications for sulfur and RVP in gasoline. Compliance options were evaluated and production estimates calculated for each refinery using Baker & O'Brien's *PRISM*™ Refining Industry Analysis modeling system. The *PRISM* model is based on publicly-available information, and incorporates Baker & O'Brien's industry experience and knowledge.

Baker & O'Brien conducted this analysis and prepared this report with reasonable care and skill, utilizing methods we believe to be consistent with normal industry practice. No other representations or warranties, expressed or implied, are made by Baker & O'Brien. All results and observations are based on information available at the time of this report. To the extent that additional information becomes

[1] Alliance of Automobile Manufacturers, "National Clean Gasoline: An Investigation of Costs and Benefits," June 2009.

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available or the factors upon which our analysis is based change, our opinions could be subsequently affected.

III. EXECUTIVE SUMMARY

In 2009, the Alliance of Automobile Manufacturers published a report[2] (the AAM Report) documenting purported costs and benefits of a single national standard for gasoline quality with significant reductions in sulfur and Reid vapor pressure (RVP) that would apply to all states except California. The AAM Report calls the new gasoline standard "National Clean Gasoline."

The American Petroleum Institute (API) engaged Baker and O'Brien, Inc. (Baker & O'Brien) to perform an independent analysis to determine the potential supply and cost impacts of lowering the specifications for sulfur and RVP in gasoline. A refinery-by-refinery analysis was performed that considered each refinery's compliance options accounting for technical, strategic, market, and economic factors, and then estimated a likely response based on this information. It is believed this approach is superior to aggregate or notional-type modeling, given the likely variation in refinery response to regulation, based on each refinery's unique position.

Implementing a nationwide (except California) summer season 7 pounds per square inch (psia) RVP specification and sulfur limits of 20 parts per million (ppm) per gallon cap and 10 ppm company annual average (the Study Case) would remove a large quantity of natural gas liquids (NGLs)[3] from gasoline. Our modeling indicates that domestic gasoline production would decrease by 1,157 thousand barrels per calendar

[2] Alliance of Automobile Manufacturers, "National Clean Gasoline: An Investigation of Costs and Benefits," June 2009.

[3] NGLs refer to a class of hydrocarbons in natural gas that are separated from the gas as liquids. NGLs include ethane, propane, butane, isobutane, and "Pentanes Plus." Pentanes Plus is a term used by the U.S. Department of Energy to describe a mixture of mainly pentanes and heavier hydrocarbon which may contain some butanes and which is obtained from the processing of raw natural gas, condensate or crude oil. The term "Pentanes Plus" is sometimes used interchangeably with the terms condensates and natural gasoline. These hydrocarbons are also produced in refineries, and in this report the term NGLs is used to describe these hydrocarbons regardless of the source.

day (MB/CD) during the summer,[4] this is equivalent to 14 percent (%) of projected summer 2016 hydrocarbon gasoline consumption.[5] If gasoline consumption remains at Base Case levels, summer gasoline imports would need to increase by 125% from 923 MB/CD in the Base Case to 2,080 MB/CD in the Study Case. It is not clear that this volume of gasoline with lower sulfur and lower RVP would be available from foreign refineries, and United States (U.S.) vulnerability to supply disruptions is obviously much greater in the Study Case.

Three Sensitivity Cases were also examined. In the first, even lower sulfur limits were imposed, and the modeling indicates a further reduction in domestic gasoline production and a still greater need for imports. In the other two, sulfur levels were the same as in the Study Case and RVP limits were relaxed slightly in some regions. The relaxation of RVP limits in these cases increased gasoline production relative to the Study Case, but the lost gasoline production relative to the Base Case was still significant.

Domestic refinery investment costs for implementing the lower sulfur and lower RVP standards considered range from $10 to $17 billion.[6] Based on investment-decision criteria described below, four to seven refineries would likely shut down rather than make the required investments. There are additional investments that would be required outside the refineries that are not included in these totals. On an annual basis, total domestic refining industry compliance costs are estimated at $5 to $13 billion.

Additional hydrotreating and fractionation required to comply would result in an increase in carbon dioxide (CO_2) emissions from refineries that continue to operate. On

[4] The analysis divided the year into two seasons. In this report, "summer" includes the months April through September inclusively. "Winter" is the remaining six months.
[5] Changes in gasoline production and imports throughout the report are hydrocarbon only. It was assumed that domestic ethanol production and consumption remain constant at Base Case levels.
[6] All costs in this report are expressed in constant 2009 U.S. Dollars.

an annual average basis, the total increase in CO_2 emissions at domestic and foreign refineries is estimated at 2.9 to 7.4 million tonnes per year.

These results are significantly different than those reported in the AAM Report. While a detailed reconciliation was not performed, there are several obvious differences in approach. The refining section of the AAM Report only considered refineries in PADDs 1, 2, and 3. According to the AAM Report, modeling was done using three aggregate refinery models, one for each of these PADDs.[7] Our analysis was done with individual models of 112 refineries, including refineries in PADDs 4 and 5. As noted in the AAM Report, the aggregate modeling approach may lead to "over-optimization" and an understatement of compliance costs.[8]

The AAM Report does not appear to consider the lost value of NGLs that would be removed from the gasoline pool, and their estimate of the volumes that would be removed appear to be much smaller than what is reported herein. The AAM Report assumes that many refineries already have the capability to produce 5 ppm sulfur gasoline.[9] Our analysis indicates that most will require capital investments to produce 5 or 10 ppm sulfur gasoline. The AAM Report also uses a capital cost estimate for new fluid catalytic cracker (FCC) gasoline hydrotreater capacity that is approximately 25% of the figure used in this report.[10] The AAM analysis does not appear to include FCC feed hydrodesulfurization revamps, expansions, or new units. These items were included in this analysis.

[7] Alliance of Automobile Manufacturers, "National Clean Gasoline: An Investigation of Costs and Benefits," June 2009, p.1-2.
[8] Ibid, p. 1-23.
[9] Ibid, p.1-19.
[10] Ibid, p.1-19.

REGULATORY ASSUMPTIONS

The Base Case in this analysis assumes that all existing fuel regulations based on existing law are fully implemented. The Study Case assumes that a lower sulfur and lower RVP standard with a nationwide (excluding California) RVP limit of 7 psia and sulfur limits of 20 ppm on individual batches and 10 ppm company annual average is implemented. Three Sensitivity Cases were also analyzed. A comparison of the key gasoline specifications in those cases and those proposed in the AAM Report is shown below. All other gasoline specifications were assumed to remain unchanged.

Regulatory Assumptions

<table>
<tr><th colspan="3" rowspan="2">Property</th><th rowspan="2">Base Case</th><th rowspan="2">Study Case</th><th colspan="3">Sensitivity Cases</th><th rowspan="2">AAM Study</th></tr>
<tr><th>Case 1</th><th>Case 2</th><th>Case 3</th></tr>
<tr><td colspan="2" rowspan="2">Sulfur, maximum ppm</td><td>Company annual average</td><td>30</td><td>10</td><td>5</td><td colspan="2">10</td><td>10*</td></tr>
<tr><td>Individual batch</td><td>80</td><td>20</td><td>10</td><td colspan="2">20</td><td>*</td></tr>
<tr><td rowspan="4">Maximum RVP, psia</td><td rowspan="2">Summer</td><td>Base</td><td rowspan="2">Varies regionally</td><td colspan="2">7.0</td><td colspan="2">7.0 to 7.8**</td><td>7.0</td></tr>
<tr><td>1 psia Waiver</td><td colspan="3">No</td><td>Varies</td><td>*</td></tr>
<tr><td rowspan="2">Winter</td><td>Base</td><td colspan="5" rowspan="2">Varies regionally</td><td rowspan="2">*</td></tr>
<tr><td>1 psia Waiver</td></tr>
<tr><td rowspan="2">Benzene, maximum Vol.%</td><td colspan="2">Company annual average</td><td colspan="6">0.62</td></tr>
<tr><td colspan="2">Refinery annual average</td><td colspan="5">1.3</td><td>*</td></tr>
<tr><td colspan="2" rowspan="2">Octane, minimum (R+M)/2</td><td>Regular</td><td colspan="5" rowspan="2">Varies regionally</td><td>87</td></tr>
<tr><td>Premium</td><td>93</td></tr>
<tr><td colspan="2" rowspan="2">ASTM Driveability Index (DI), maximum***</td><td>Summer</td><td colspan="5" rowspan="2">Varies regionally</td><td>1,250*</td></tr>
<tr><td>Winter</td><td>*</td></tr>
<tr><td colspan="3">Ethanol, fixed Vol.%</td><td colspan="6">10</td></tr>
</table>

* It is not clear from the AAM Report how the sulfur, RVP, and ASTM DI maximums would be applied. A blending limit of 5 ppm, 6.8 psia, and 1,220 for sulfur, RVP, and DI, respectively, was reportedly used in the refinery modeling work. It is also not clear what volatility limits would apply during the non-summer seasons or if the refinery annual average for benzene would remain unchanged.

**RVP limited to 7.0 psia in current RFG areas and other areas currently requiring 7.0 psia. RVP limited to 7.8 psia in all other regions except California.

*** No units apply, but in this context, temperatures are measured in degrees Fahrenheit (°F).

Most of the analysis described in this report was completed before the Environmental Protection Agency (EPA) approval of a gasoline formulation with 15% ethanol for late-model automobiles. Because of the uncertainty in what specifications for motor gasoline containing more than 10% ethanol might be, it was assumed that the 10% limit would remain in place on all motor gasoline other than E85.[11] The analysis is, therefore, focused on the impact of the potential lower sulfur and lower RVP specifications, and complications related to changes in ethanol content are avoided.

TECHNOLOGY AND INVESTMENT COSTS

There are significant differences in gasoline sulfur and summer RVP specifications between the Base, Study, and Sensitivity Cases. The summer RVP limits in the Study and Sensitivity Cases would require removal of additional low boiling point, high RVP blendstocks from the gasoline pool at many refineries. New fractionation towers would be required at many refineries to accomplish this.

To reduce sulfur in finished gasoline, further reductions in FCC gasoline sulfur would be required. The Tier 2 gasoline regulations that took effect in 2004 caused almost all refiners to lower FCC gasoline sulfur by desulfurizing FCC gasoline and/or FCC feed. Additional reductions would be required to meet the Study and Sensitivity Cases' sulfur standards. This would require a combination of new desulfurization units and revamps and expansions of existing units.

New or expanded loading and unloading facilities (storage tanks, piping, vapor recovery systems, pumps, rail car loading spots, etc.) would be required at refineries to handle the volume of NGLs that would be extracted and sold as a result of lower summer RVP specifications. The scope of such modifications would vary by refinery and depends on a refiner's existing loading/unloading infrastructure and capability.

[11] E85 refers to a gasoline-ethanol blend containing a nominal 85% ethanol by volume.

Transportation of the displaced surplus NGLs would be a challenge. Much of this material would need to be shipped in special-purpose rail cars. Additional rail cars, storage, and handling facilities would be required.

ANALYTICAL BASIS

Each refinery is unique, given its current technology, location, product slate, etc. Therefore, a refinery-by-refinery analysis was performed that considered each refinery's compliance options accounting for technical, strategic, market, and economic factors, and then estimated a likely response based on this information. It is believed this approach is superior to aggregate or notional-type modeling, given the likely variation in refinery response to regulation, based on each refinery's unique position.

Baker & O'Brien's proprietary *PRISM*™ Refining Industry Analysis modeling system was used extensively throughout this study. The *PRISM* system includes a sophisticated, mass-balanced refinery simulator and models of virtually every refinery in North America.

The Study Case summer RVP requirement would cause many refineries to produce additional NGLs that cannot be blended in gasoline. A surplus of NGLs would likely be resolved through a combination of a number of actions including:

- A reduction in butane and/or pentane imports;
- Substitution of butane and/or pentane for other chemical industry feedstock;
- An increase in butane and/or pentane exports to foreign markets;
- Consumption or sales of butane and/or pentane as fuel or as feedstock for hydrogen production;
- Alkylation of FCC Pentanes;[12] and
- Seasonal stockpiling of NGLs.

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[12] The term FCC Pentanes refers to the mix of 5-carbon molecules produced from an FCC unit and includes C5 olefins and di-olefins.

The quantity of NGLs that would need to be removed from gasoline during the summer in both the Study and Sensitivity Cases is quite large. This would have a significant impact on the value of these hydrocarbons. Because the incremental or lowest value market for the surplus NGLs would be a substitute for natural gas, that portion of the displaced NGLs would have to compete with natural gas. Refiners selling these hydrocarbons into that market would only realize a value roughly equivalent to natural gas. Using a pricing scenario consistent with Annual Energy Outlook 2010 (AEO 2010), this value is significantly less than the value as gasoline blendstocks. This lost value has been treated as a cost to refiners, in addition to the investment and operating costs required to meet the gasoline specifications in the Study and Sensitivity Cases.

A stepwise refinery-by-refinery approach was utilized in analyzing compliance options. If the investment required at any refinery exceeded its value as an ongoing concern (assumed to be five times the future annual net cash flow), then it was assumed that the refinery would stop making gasoline and/or shut down.

The demand side response to the Study and Sensitivity Case scenarios has not been analyzed. Gasoline consumption has been held constant in all Cases. Imports in the Base Case are consistent with the AEO 2010 Reference Case and history. The availability of imports to meet the requirements of the other Cases was not assessed.

STUDY RESULTS

In the Base Case, U.S. refiners are projected to supply 7,435 MB/CD of gasoline during the summer, meeting 87% of the domestic requirement in 2016. Non-refinery domestic gasoline production is estimated to be 200 MB/CD, and 923 MB/CD of imported gasoline (excluding ethanol) would be required to meet the summer U.S. consumption forecast of 8,558 MB/CD. Foreign refiners have supplied the U.S. market

with this magnitude of gasoline in recent years, but the ability of foreign refineries to supply the 2016 requirements was not analyzed.

In the Base Case, 112 refineries were producing non-California gasoline (including some California refineries). In the Study Case and Sensitivity Cases 2 and 3, it was projected that four refineries would likely shut down rather than make the investments required to comply with the lower sulfur and lower RVP specifications. In Sensitivity Case 1 the number of refineries that are projected to shut down increases to seven. These refineries are projected to have the potential to make 110 MB/CD of gasoline with lower sulfur and lower RVP in the Study Case, 170 MB/CD in Sensitivity Cases 2 and 3, and 206 MB/CD in Sensitivity Case 1 if they did make the investment. The estimated compliance investments for the remaining refineries (net of shutdowns) are shown below.

Expected Refinery Compliance Investments

	Study Case	Sensitivity Case 1	Sensitivity Case 2	Sensitivity Case 3
Refinery Shutdowns	4	7	4	4
Number of New Units				
Naphtha Depentanizer	45	43	27	16
FCC Depentanizer	40	38	9	9
Hydrocracker Depentanizer	23	22	2	2
FCC Feed Hydrotreater	1	8	1	1
FCC Gasoline Hydrotreater	9	20	9	9
Number of Revamps and Expansions				
FCC Feed Hydrotreater	30	28	27	27
FCC Gasoline Hydrotreater	32	38	30	30
Logistics/Tankage, $MM	977	1,114	609	366
Total Investment Cost, $MM	11,488	17,343	9,957	9,577

Note: Individual refineries may appear in multiple categories for each case.

To meet the Study and Sensitivity Case summer RVP specification, 315 to 934 MB/CD of NGLs would be removed from the gasoline blend pool. In the Study Case, the resulting decrease in summer refinery gasoline production is estimated at 1,157 MB/CD versus (vs.) the Base Case. This is equivalent to 14% of projected 2016 summer hydrocarbon gasoline consumption. In Sensitivity Case 1 the lost production increases to 1,377 MB/CD of domestic gasoline production. In Sensitivity Cases 2 and 3, the reduction vs. the Base Case is 873 and 622 MB/CD, respectively.

Because refiners are already running at maximum volatility limits during the winter, there is no room to reabsorb the NGLs displaced during the summer into the

winter gasoline pool. Other outlets would need to be found. The magnitude of these volumes would likely have a significant impact on the U.S. refining, chemicals, and NGL markets. Investments required by refiners to modify their storage, loading, and unloading facilities to store and transport surplus summer butanes and pentanes are estimated at $400 million (in Sensitivity Case 3) to $1.1 billion (in Sensitivity Case 1). Additional investments would be required outside the refining industry to transport and handle these NGLs.

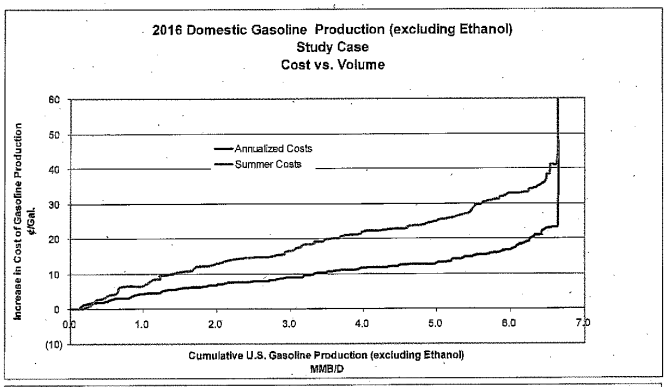
The downgrade in NGLs value is by far the largest compliance cost. Capital investment costs are second. Refinery investment costs range from $9.6 billion (in Sensitivity Case 3) to $17.3 billion (in Sensitivity Case 1). As mentioned, there are additional investments that would be required outside the refineries that are not included in these totals.

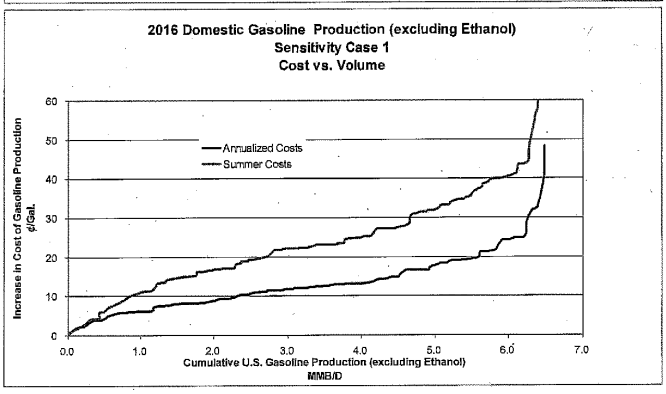
The total annual compliance cost borne by refiners for the Study and Sensitivity Cases is shown below:

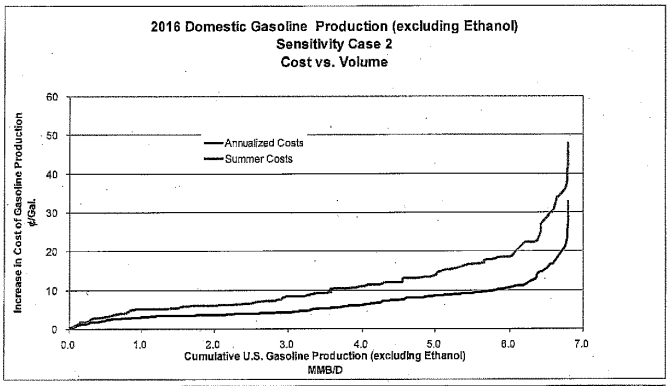
Total Annual Compliance Cost
2009 $MM per Year

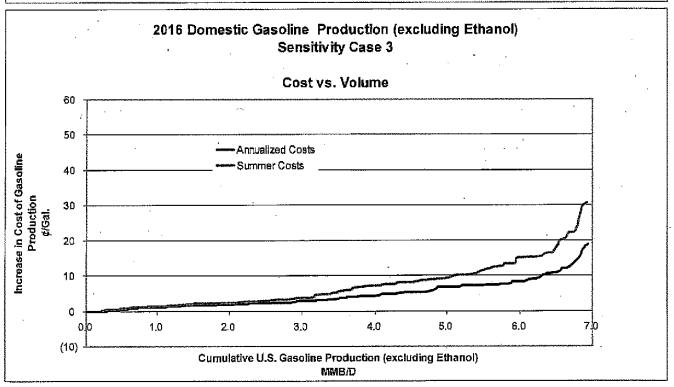
	Study Case	Sensitivity Case 1	Sensitivity Case 2	Sensitivity Case 3
Purchased Hydrogen	305	546	354	354
Other Variable Operating Expenses	498	749	342	303
Fixed Operating Expenses	269	404	37	35
Capital Recovery	1,953	2,949	1,693	1,628
Light Hydrocarbon Downgrading	7,368	8,572	4,363	2,528
Total Cost	10,393	13,220	6,789	4,848

The annualized and summer compliance costs for individual refineries are shown for the Study and Sensitivity Cases in graphs that follow.






2016 Domestic Gasoline Production (excluding Ethanol)
Sensitivity Case 2
Cost vs. Volume
Increase in Cost of Gasoline Production ¢/Gal.
Annualized Costs
Summer Costs
60
50
40
30
20
10
0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
Cumulative U.S. Gasoline Production (excluding Ethanol) MMB/D


2016 Domestic Gasoline Production (excluding Ethanol)
Sensitivity Case 3
Cost vs. Volume
Increase in Cost of Gasoline Production ¢/Gal.
Annualized Costs
Summer Costs
60
50
40
30
20
10
0
(10)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
Cumulative U.S. Gasoline Production (excluding Ethanol) MMB/D

LETTERS FROM AUTOBILE MANUFACTURERS TO HONORABLE LISA JACKSON, ADMINISTRATOR, ENVIRONMENTAL PROTECTION AGENCY

F. JAMES SENSENBRENNER, Jr.
FIFTH DISTRICT, WISCONSIN
COMMITTEE ON THE JUDICIARY
SUBCOMMITTEE ON CRIME, TERRORISM, AND HOMELAND SECURITY
CHAIRMAN
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
VICE-CHAIRMAN

Congress of the United States
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HTTP://SENSENBRENNER.HOUSE.GOV

July 5, 2011

The Honorable Lisa Jackson
Administrator
The Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, DC 20004

Dear Administrator Jackson,

The Environmental Protection Agency (EPA) is increasingly out of touch with American consumers. Rebuilding our economy doesn't require that we sacrifice our environmental ideals, but the costs of agency actions must be balanced against the environmental benefits. Increasingly, the EPA seems focused on regulatory action with crippling costs and, at best, minimal environmental benefits.

The EPA recently issued a waiver to allow gasoline blends of up to 15% ethanol (E15) in cars and trucks of model year 2001 and later. This decision was apparently based on narrow Department of Energy testing that did not consider the effect that E15 would actually have on car engines.

On June 1, 2011, I wrote to 14 auto manufacturers and asked 3 questions: (1) Will E15 damage engines of model year 2001 and later? (2) Will your warranties cover damage from E15? and (3) Will E15 negatively affect fuel efficiency?

Engine manufacturers have been nearly unanimous in their beliefs that E15 will damage engines, void warranties, and reduce fuel efficiency. In difficult economic times, consumers need to get more miles from a gallon of gas and extend the lives of their cars. EPA's waiver threatens the already precarious financial situation of American families with no discernible environmental benefit.

I have attached all the responses, but want to highlight quotes from each manufacturer:

> Chrysler: "We are not confident that our vehicles will not be damaged from the use of E15 . . . The warranty information provided to our customers specifically notes that use of the blends beyond E10 will void the warranty."
>
> Ford: "Ford does not support the introduction of E15 into the marketplace for the legacy fleet . . . Fuel not approved in the owner's manual is considered misfueling and any damage resulting from misfueling is not covered by the warranty."
>
> Mercedes-Benz: "Any ethanol blend above E10, including E15, will harm emission control systems in Mercedes-Benz engines, leading to significant problems."

Honda: "Vehicle engines were not designed or built to accommodate the higher concentrations of ethanol . . . There appears to be the potential for engine failure."

Mazda: "The record fails to demonstrate that motor vehicles would not be damaged and result in failures when run on E15."

Toyota: "Toyota cannot recommend the use of fuel with greater than E10 for Toyota vehicles currently on the road . . . Our policy remains that we will not provide warranty coverage for issues arising from the misuse of fuels that exceed specified limits."

Nissan: "We are not at all confident that there will not be damage to MY 2001 and later vehicles that are fueled with E15. In our view the record fails to demonstrate that motor vehicles . . . would not be damaged and result in failures when run on E15."

Volkswagen: "Volkswagen agrees that the EPA did not conduct an adequate test program when E15 was considered and then approved for use in conventional vehicles. . . Our current warranty will not cover problems stemming from the use of E15."

Volvo: "The risks related to emissions are greater than the benefits in terms of CO_2 when using low-blend E15 for variants that are designed to E10."

BMW: "BMW Group engines and fuel supply systems can be damaged by misfueling with E15 . . . Damage appears in the form of very rapid corrosion of fuel pump parts, rapid formation of sludge in the oil pan, plugged filters, and other damage that is very costly to the vehicle owner."

Hyundai: "The EPA tests failed to conclusively show that the vehicles will not be subject to damage or increased wear."

Kia: "EPA testing failed to determine that vehicles will not be subject to damage or increased wear."

And the problems do not stop there. On June 22, 2011, I sent a second letter to small engine manufacturers. While the EPA's waiver does not apply to small engines, many small engines are fueled remotely—gasoline is initially filled into a container which is then used to fuel the engine. This creates a substantial risk of misfueling despite the EPA's labeling efforts. In my June 22 letter, I asked small engine manufacturers if they were confident that the EPA had done enough to avoid misfueling and whether they thought E15 would damage their engines. In the limited responses I have received, small engine manufacturers have expressed significant concerns. These responses are also attached.

E15 is a product that simply does not belong in the marketplace. I am writing to urge the EPA to heed these warnings and reconsider its E15 waiver. In furtherance of my work on the House Science, Space and Technology Committee and on behalf of my constituents, please respond to the following questions by July 21, 2011:

1. Did the EPA consider the effects E15 would have on engine durability and fuel efficiency before granting its waiver?
2. Is the EPA confident that E15 will not damage car engines in model years 2001 and later?

3. What effect does the EPA believe that E15 will have on fuel economy?
4. Does the EPA believe that its recent labeling safeguards for E15 will be sufficient to prevent misfueling in car and truck engines older than model year 2011 and in small engines?

I greatly appreciate your prompt response and attention to this matter.

Sincerely,

F. James Sensenbrenner, Jr.
Vice-Chairman, House Committee on Science, Space, and Technology

cc: The Honorable Ralph Hall
Chairman, Committee on Science, Space, and Technology

The Honorable Eddie Bernice Johnson
Ranking Member, Committee on Science, Space, and Technology

KIA MOTORS

Kia Motors Corporation Washington Office
1660 L Street, NW, Suite 201
Washington, DC 20036
Tel: 202-503-1515 Fax: 202-503-1516

July 1, 2011

The Honorable F. James Sensenbrenner, Jr.
Vice-Chairman, House Committee on Science, Space and Technology
United States House of Representatives
Room 2499
Rayburn House Office Building
Washington, DC 20515-5101

Dear Vice-Chairman Sensenbrenner,

Thank you for your June 1, 2011 letter to Kia Group President and Chief Executive Officer Byung Mo Ahn inquiring on Kia's views of ethanol blends and the Environmental Protection Agency (EPA) efforts to change the levels of use by 50 percent or to an E15 level. We are honored to be asked to comment on your work for the House Committee on Science, Space and Technology and are pleased to respond to your specific questions on E15.

Overall, Kia believes more testing is required before introducing a new fuel into the marketplace. Scientific review can determine the positive and negative impact a new fuel can have on air quality, consumer acceptance and engine durability.

We have addressed your questions outlined in the June 1 letter:

***Question One** on confidence that our cars and trucks from model year 2001 and later will not be damaged by or wear out more quickly from the use of E15;* **EPA testing failed to determine that vehicles will not be subject to damage or increased wear. Therefore Kia has no basis to conclude that vehicles will not be damaged by or wear out faster due to the use of E15.**

***Question Two** concerning current warranties and potential problems stemming from the use of E15 in cars and trucks from model year 2001 and later;* **On pages 9-10 of the Warranty Manual, Kia states: "Improper maintenance or the use of other than the specified fuel, oil or lubricants recommended in your Owner's Manual. It is your obligation to ensure that you obtain all fuels, oils and lubricants from reliable vendors using quality products which meet the Kia specifications identified in your Owner's Manual. In the event that problems result to your vehicle due to service from vendors who use reduced quality products, your vehicle warranties will not provide coverage."**

KIA MOTORS

Kia Motors Corporation Washington Office
1660 L Street, NW, Suite 201
Washington, DC 20036
Tel: 202-503-1515 Fax: 202-503-1516

Kia's Owner's Manual in section 1, page 3 provides that owner's shouldn't use anything greater than 10% ethanol and that a 15% mixture will damage the vehicle. (Kia Warranty and Owner's Manuals are attached for your review)

Question Three on the effect of E15 on the fuel efficiency of our engines; Kia believes that E15 will lead to degradation in fuel efficiency due to the lower energy content than gasoline.

Thank you for your letter and the opportunity to share our views on E15. If you have further comments or questions, I can be reached on 202 503-1515 or jta@kia-dc.com.

Sincerely,

J. T. Anderson

John T. Anderson
Director, Kia Government Affairs

cc: The Honorable Ralph Hall
Chairman, Chairman Committee on Science, Space and Technology

The Honorable Eddie Bernice Johnson
Ranking Member, Committee on Science, Space and Technology

Mr. Byung Mo Ahn
Group President and Chief Executive Officer
Kia Motors America

HONDA

Honda North American, Inc.
1001 G Street, N.W. Suite 950
Washington, D.C. 20001
Phone (202) 661-4400

June 13, 2011

Hon. F. James Sensenbrenner, Jr.
Vice Chairman
Committee on Science, Space, and Technology
House of Representatives
Washington, D.C. 20515-4905

Dear Mr. Vice Chairman:

Mr. Tetsuo Iwamura, President and Chief Executive Office of American Honda Motor Company, Inc., has asked that I respond to your June 1, 2011, letter regarding the Environmental Protection Agency's recent approval of a blend of 15 percent ethanol (E15) for use in cars and trucks of Model year 2001 or later. You have raised the following three questions:

1. **Are you confident that your cars and trucks from model year 2001 and later will not be damaged by or wear more quickly from use of E15?**

As you know, the Clean Air Act requires motor vehicle manufacturers to certify that the vehicles they sell will meet or exceed emissions standards in effect at the time each vehicle is introduced into commerce. There are specific testing protocols that must be employed for certification, including specifications for fuels used in the vehicles during testing. As a result, we engineer our vehicles to meet or exceed the standards utilizing the prescribed test fuel, which never has contained ethanol. However, given the fuels prevalent in the market over the last decade, the engines in Model Year 2001 later vehicles were built to operate on fuels with ethanol concentrations of up to 10% (E10).

Authorizing the sale of E15 in 2010 for vehicles built after 2001 presents an obvious problem for auto manufacturers -- vehicle engines were not designed or built to accommodate the higher concentrations of ethanol. The differences between E10 and E15, including E15's higher oxygen content, lower energy content and heightened corrosivity, require use of more robust component materials and different engine calibrations. The engines in our Model Year 2001 and later vehicles do not have those necessary materials or calibrations.

In our owner's manuals, Honda requires its customers to refuel their vehicles with E10 or below. The impact of E15 on our engines is not completely known at this stage, although there appears to be the potential for engine failure. During the EPA's consideration of the partial waiver approving the use of E15, Honda and its trade association, the Association of International Automobile Manufacturers (AIAM) (now known as Global Automakers), urged the agency to defer its decision until such time as the testing program on the impact of E15 on vehicles is complete. The testing is being managed by the Coordinating Research Council (CRC), an independent organization funded by the automobile and oil industries, with limited contributions from the U.S. government. Honda is a member of the CRC and active in its testing.

It is unfortunate that EPA did not wait for the results of the seven major test programs that are being undertaken by CRC. These programs include critical tests for engine durability and fuel system material compatibility. Potential E15-related failures have already been identified in some of these programs, including the possible confounding of a vehicle's on-board diagnostic system. This can lead to illumination of the "check engine" light when in fact there is no malfunction, or the failure of the light to illuminate when there is a problem.

Because E15 has not been in the market and our engines were not designed for its use, we do not have a detailed understanding of the implications of the widespread use of the fuel in our vehicles. However, these early results from the CRC testing cause us concern. The CRC studies are due to be completed beginning in late-2011.

2. **Will your current warranty cover potential problems stemming from the use of E15 in cars and trucks from model year 2001 and later?**

As noted above, Honda products were designed, built and certified to operate on E10 and below. Use of higher blends could compromise the vehicle's warranty.

3. **Will E15 affect the fuel efficiency of your engines?**

Ethanol contains less energy than gasoline on a gallon-for-gallon basis. Accordingly, customers can expect to experience about 5% - 6% inferior fuel economy using E15 rather than E0 (the difference between E10 and E15 will be smaller). Customers using E85 (in a vehicle designed to use E85) instead of E10 will experience about a 27% decrease in fuel economy. For example, a vehicle that gets 300 miles to the tank on today's gasoline will likely achieve only about 219 miles to the tank with E-85.

If you have further questions regarding E15, please feel free to contact me at (202) 661-4400.

Sincerely,

Edward B. Cohen
Vice President
Government & Industry Relations

cc: The Honorable Ralph Hall, Chairman
Committee on Science, Space, and Technology

The Honorable Eddie Bernice Johnson, Ranking Member
Committee on Science, Space, and Technology

CHRYSLER

Jody Trapasso
Senior Vice President
External Affairs

June 23, 2011

The Honorable F. James Sensenbrenner, Jr.
Vice-Chairman
House Committee on Science, Space and Technology
U.S. House of Representatives
2449 Rayburn House Office Building
Washington, DC 20515-4905

Dear Vice-Chairman Sensenbrenner:

Sergio Marchionne asked me to respond to your June 1, 2011 letter requesting information about the Environmental Protection Agency's (EPA or Agency) decisions to allow the use of 15 percent ethanol (E15) in passenger cars and light trucks beginning with the 2001 Model Year (MY).

Beginning in the late 1970's, Chrysler was one of the first automakers to endorse and support the use of "gasohol" (i.e., gasoline with up to 10 percent ethanol, or E10). Since then, all of our conventional gasoline-fueled cars and trucks have been designed and warranted for E10 operation. Chrysler has also produced Flexible-Fuel Vehicles (FFVs) since the 1998 MY and voluntarily committed that 50 percent of our fleet produced by 2012 will be capable of operating on renewable fuels. These vehicles are designed, warranted and developed to operate on gasoline, E85 ethanol or any blend in between.

While Chrysler has been a strong advocate of renewable fuels, we have concerns about the potential harmful effects of E15 in engines and fuel systems that were not designed for use of that fuel. In cooperation with other automakers, we have been conducting tests of vehicles in the 2001 and later model year vintage to assess the effect of E15 on their engines and fuel systems. Prior to EPA's decisions to allow E15, we had requested that the Agency defer from making any decisions regarding higher ethanol blends for conventional vehicles until existing testing programs have been completed and the data fully evaluated.

Chrysler Group LLC | CIMS 936-00-00 | 1401 H Street, NW, Suite 709 | Washington, DC USA | 20005
Phone 202.414.6756 | Fax 202.414.6729 | jody.trapasso@chrysler.com

Provided below are answers to the three specific questions asked in your letter.

1. Are you confident that your cars and trucks from model year 2001 and later will not be damaged by or wear more quickly from use of E15?

No, we are not confident that our vehicles will not be damaged from the use of E15. While future products could be designed to accommodate E15 or other mid-level blends of ethanol, testing to date suggests that both newer and older models (non-FFVs) may experience more engine wear and fuel system damage from the use of E15.

2. Will your current warranty cover potential problems stemming from the use of E15 in cars and trucks from model year 2001 and later?

No. Chrysler's conventional vehicles (non-FFVs) are only warranted for use of E10. The warranty information provided to our customers specifically notes that use of blends beyond E10 will void the warranty.

3. Will E15 affect the fuel efficiency of your engines?

Yes. The energy content (Btu/gallon) of fuel decreases as the ethanol concentration increases. As a result, we expect the fuel efficiency of our conventional products (non-FFVs) to decrease with any increase in ethanol content.

I hope that this information responds to your request. Please do not hesitate to contact me if you need any additional information.

Sincerely,

Jody Trapasso



Susan M. Cischke
Group Vice President-Sustainability,
Environment & Safety Engineering

World Headquarters
One American Road
Dearborn, MI 48126-2798 U.S.A

June 8, 2011

The Honorable James Sensenbrenner, Jr.
Vice-Chairman, House Committee on
Science, Space, and Technology
Rayburn House Office Building, Room 2449
Washington, D.C. 20515

Dear Vice-Chairman Sensenbrenner:

Alan Mulally has asked me to respond to your letter of June 1 regarding the introduction of E15 fuel into the marketplace.

At Ford, we recognize the need to increase the use of biofuels to meet the country's goals of energy security and reduced greenhouse gas emissions. Ford has produced, and continues to offer, a substantial number of flexible fuel vehicles (FFV) capable of operating on E85 (85% ethanol) across many models. The renewable fuel standard, passed into law in 2007, requires 36 billion gallons of biofuels to be blended into transportation fuel by 2022. In order to meet that goal, the country needs to increase the use of ethanol beyond the 10% (E10) used today, but needs to do so in a fashion that does not have a negative impact on the legacy fleet.

This can be accomplished by taking a prospective approach to the introduction of mid-level blends whereby manufacturers, provided with enough lead time, can design new vehicles with the capability of accommodating the new fuel. Likewise, the lead time will give fuel providers an opportunity to prepare to make the new fuel available nationwide. In contrast, an approach in which fuel specifications are changed abruptly, and the new fuel is allowed to be used on vehicles that were not designed for it, is likely to lead to undesirable outcomes for consumers, the new fuel, and the legacy vehicles.

Below are answers to your specific questions:

Q1 Are you confident that your cars and trucks from model year 2001 and later will not be damaged by or wear more quickly from use of E15?

Ford does not support the introduction of E15 into the marketplace for the legacy fleet. The entire legacy fleet of non-FFVs, including vehicles built in model year 2001 and later, consists of vehicles that were designed to operate in a range of fuels from pure gasoline up to a blend of 10 percent ethanol (E10) -- not E15. We remain concerned that legacy fleet, operating on a fuel the vehicles were not designed for, will not meet customer expectations for quality, durability, performance and fuel economy, as well as legal requirements to meet emission standards and

on-board diagnostic regulations. Efforts to increase renewable fuel use must be carried out in a way that does not create undue risks and problems for existing vehicles on the road.

Q2 Will your current warranty cover potential problems stemming from the use of E15 in cars and trucks from model year 2001 and later?

The owners' manuals for these legacy vehicles do not identify E15 as a fuel that may be used in the vehicles. They go on to say that the use of a fuel not approved in the owners' manual is considered misfueling, and that any damage resulting from misfueling is not covered by the warranty. To the extent that E15 is introduced into commerce, we will work with our customers and dealerships as best we can to address any potential concerns, but we cannot redesign vehicles that have already been built and sold.

Q3 Will E15 affect the fuel efficiency of your engines?

Going from the generally available E10 fuel to E15 will not have a significant impact on the efficiency of the engine, but because ethanol contains less energy per a given volume of fuel, customers will experience slightly lower miles per gallon when driving on E15 versus E10.

Ford appreciates the opportunity to provide our views on this subject. Thanks again for your continued support of the automotive industry.

Sincerely,

Susan M. Cischke
Group Vice President
Sustainability, Environment & Safety Engineering
Ford Motor Company

cc: The Honorable Ralph Hall
Chairman, Committee on Science, Space, and Technology

The Honorable Eddie Bernice Johnson
Ranking Member, Committee on Science, Space, and Technology

Mazda North American Operations

James J. O'Sullivan
President and CEO



June 7, 2011

The Honorable F. James Sensenbrenner
Vice-Chairman
House Committee on Science, Space and Technology
United States House of Representatives
2449 Rayburn House Office Building
Washington, D.C. 20515-4905

Dear Vice-Chairman Sensenbrenner:

We appreciate receiving your June 1, 2011 letter regarding EPA's two partial waiver decisions that permit the sale of gasoline containing up to 15 percent ethanol (E15) for 2001 model year (MY) and newer passenger cars and light trucks. We believe that increasing the allowable ethanol content in gasoline by 50 percent will have unintended consequences for auto manufacturers, consumers, fuel suppliers and distributors. Mazda's primary concern about an E15 waiver is the overriding need for consumer satisfaction.

Specifically, your letter asks for responses to the following three questions. Our responses are provided below.

1. **Are you confident that your cars and trucks from model year 2001 and later will not be damaged by or wear more quickly from use of E15?**

   No, we are not at all confident that there will not be damage to MY 2001 and later vehicles that are fueled with E15. In our view, the record fails to demonstrate that motor vehicles (other than FFVs) would not be damaged and result in failures when run on E15. No Mazda vehicles were included in the models tested by the government.

2. **Will your current warranty cover potential problems stemming from the use of E15 in cars and trucks from model year 2001 and later?**

   Mazda vehicles covered by the waiver were designed to use a maximum of E10. The direction in the owner guides of Mazda vehicles reflects the fact that they were not designed to run on E15. EPA regulations allow manufacturers to deny warranty coverage for vehicles damaged due to mis-fueling (based on the owner's manual instructions). We are encouraging Mazda vehicle owners to continue to consult their owners' manuals for information regarding the appropriate fuel for their vehicles.

7755 Irvine Center Drive Irvine,CA 92618-2922 Telephone 949 727 1990
PO Box 19734 Irvine,CA 92623-9734 Facsimile 949 727 6529 Internet http://www.mazdausa.com

Mazda owner's manuals specify the following:

> *"Your vehicle can use only oxygenates that contain no more than 10 percent ethanol by volume. Harm to your vehicle may occur when ethanol exceeds this recommendation, or if the gasoline contains any methanol."*
>
> *"Vehicle damage and drivability problems resulting from the use of the following may not be covered by the Mazda warranty.*
> - *Gasohol containing more than 10% ethanol.*
> - *Gasoline or gasohol containing methanol.*
> - *Leaded fuel or leaded gasohol."*

3. **Will E15 affect the fuel efficiency of your engines?**

   Yes. A gallon of ethanol has lower energy content than a gallon of gasoline. Therefore, any increase in ethanol content will necessarily degrade fuel economy.

Thank you for considering our views. If you have any questions about this information, please contact Barbara Nocera at bnocera@mazdausa.com or 202.467.5096.

Sincerely,

James J. O'Sullivan

cc: The Honorable Ralph Hall
Chairman, Committee on Science, Space, and Technology

The Honorable Eddie Bernice Johnson
Ranking Member, Committee on Science, Space, and Technology

BMW Group

June 23, 2011

The Honorable F. James Sensenbrenner, Jr.
Vice-Chairman
House Committee on Science, Space, and Technology
United States House of Representatives
Washington, DC 20515-4905

Dear Mr. Vice-Chairman:

This is in response to your June 1, 2011 letter regarding the recent approvals by the EPA to permit a gasoline blend of 15 percent ethanol (E15) for use in model year 2001 and later passenger cars and light trucks. Our Chairman asked me to respond to your request.

On behalf of BMW of North America, LLC (BMW NA), please find below your questions followed by our answers.

1. *Are you confident that your cars and trucks from model year 2001 and later will not be damaged by or wear more quickly from use of E15?*

   BMW NA Response: No. BMW Group engines and fuel supply systems can be damaged by misfueling with E15. BMW has designed its engines and fuel systems to operate with gasoline up to E10 and our owners have already experienced damage when, for example, a gasoline terminal mixes greater than 10% ethanol into the tanker. As a result of periodic damage, BMW NA has issued Service Information Bulletins (attached) warning of potential damage, and our dealers have ethanol test kits to measure the percentage of ethanol in the vehicle's tank.

   Damage appears in the form of very rapid corrosion of fuel pump parts, rapid formation of sludge in the oil pan, plugged filters, and other damage that is very costly to the vehicle owner.

   As you would expect, engines and fuel systems already on the road cannot be retroactively designed to be compatible with ethanol blends higher than used for the original design.

2. *Will your current warranty cover potential problems stemming from the use of E15 in cars and trucks from model year 2001 and later?*

   BMW NA Response: No. Our warranty states that it does not cover malfunctions caused by use of fuels containing more than 10% ethanol. Our dealers have an alcohol detection tool to identify ethanol blends that exceed the allowable 10% maximum. We anticipate that the owners of vehicles damaged by higher levels of ethanol will be frustrated, notwithstanding the warnings contained in our warranty booklets.

Company
BMW of North America, LLC

BMW Group Company

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Tom.Beloga@bmwna.com

3. Will E15 affect the fuel efficiency of your engines?

Response: Yes. Engine compression ratios, turbo-charging pressures, and control mapping are designed to optimize fuel economy, performance, and emissions based on a maximum of E10. Since ethanol has about 34% less energy than gasoline, an engine designed to run on up to E10 will suffer a corresponding loss in fuel economy. More importantly, use of ethanol blends higher than E10 in the wrong engines will result in drivability problems at high and low temperatures including hard starting, stalling, and hesitation.

Recommendations

BMW NA respectfully makes the following recommendations if increased percentages of ethanol in gasoline are required:

- Legacy E10 gasoline must be required by law for the next 15 years to accommodate vehicles, motorcycles, and other power equipment currently in use that would be damaged by E10+.
- Implementation of effective efforts to prevent misfueling, including requiring strong language on pump labels on E10+ pumps that warn of damage from misfueling and advise users to "Check your owner's manual for ethanol warnings," and consider the use of a different nozzle size for E10+ pumps to diminish the chance of inadvertent misfueling.
- An ethanol misfueling owner reimbursement clearinghouse, funded by the ethanol industry, should be established by law to allow owners to recoup repair costs from misfueling damage. Vehicle OEMs and gas station owners should be indemnified from damages caused by misfueling.
- By law, before a gas station storage tank is filled with ethanol blends greater than E0 or E10 for the first time, the tank must be cleaned and filters installed to prevent newly-dissolved dirt caused by water and alcohol from being pumped into consumers' tanks.
- In general, we favor the introduction of an increase to E20 in ethanol content together with a 5 year minimum lead time for engine and fuel system developers.

If you or your staff has further questions, please contact me at 201-571-5071.

Sincerely,

Thomas C. Baloga
Vice President,Engineering US

cc: The Honorable Ralph Hall
Chairman, Committee on Science, Space, and Technology

The Honorable Eddie Bernice Johnson
Ranking Member, Committee on Science, Space, and Technology

Enclosures

Service Information

Fuel Systems B13 06 10

This Service Information bulletin replaces SI B13 04 06 dated August 2006.

SUBJECT

Testing Fuel Composition

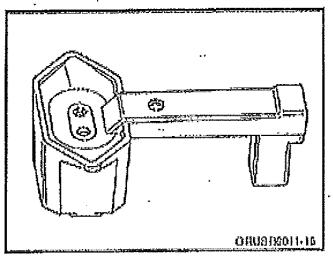
MODEL

All

SITUATION

Fuel blends containing a high percentage of alcohol (10% and above), mainly ethanol, are becoming more commercially available. Usage of E85 or any other high alcohol content blend (e.g., E30) in BMW vehicles will cause various drivability complaints (cold start problems, stalling, reduced performance, poor fuel economy, etc.); may cause excessive emissions; and may cause irreversible damage to engine, emission control and fuel delivery systems due to incompatibility of materials with alcohols. Refer to SI B13 01 06 Alcohol Fuel Blends in BMW Vehicles for complete details.

In order to correctly diagnose various drivability complaints caused by fuel blends with a high level of ethanol content, BMW is providing you with an electronic fuel composition tester.



Fuel Composition Tester
P/N 83 30 0 439 685

Refer to B04 04 11 for more details.

PROCEDURE

Safety Precautions:

- Gasoline is highly flammable; observe normal precautions for working with flammable liquids. Perform all tests away from any source of ignition. A class B fire extinguisher must be available.
- Wear protective eye protection with side shields and Nitrile rubber gloves for handling the tester.
- Please adhere to any applicable OSHA regulations when handling gasoline.
- Dispose of the mixture according to local, state and federal regulations.

Refer to the attached procedure for testing the fuel composition of gasoline.

WARRANTY INFORMATION

Component damage, malfunctions, or any drivability problems verified to be caused by the use of fuels containing more than 10% ethanol (or other oxygenates with more than 2.8% oxygen by weight) will not be covered under BMW warranties as this is not considered a defect in materials or workmanship. Always document the results found on the vehicle repair order whenever performing this test.

Service Information

Fuel Systems B13 01 06

This Service Information bulletin supersedes SI B13 01 06 dated September 2006.

Changes to this revision are identified by a black bar.

SUBJECT

Alcohol Fuel Blends in BMW Vehicles

MODEL

All with gasoline engines

SITUATION

Fuel blends containing a high percentage (above 10%) of alcohol, mainly ethanol, are becoming more commercially available. Customers inquire about the possibility of using alcohol fuels (e.g., E85) in BMW vehicles.

INFORMATION

Fuels containing up to and including 10% ethanol; or other oxygenates with up to 2.8% oxygen by weight, that is, 15% MTBE (methyl tertiary butyl ether); or 3% methanol plus an equivalent amount of cosolvent will not void the applicable warranties with respect to defects in materials or workmanship.

Usage of such alcohol fuel blends may result in drivability, starting, and stalling problems due to reduced volatility and lower energy content of the fuel. Those drivability problems may be especially evident under certain environmental conditions such as high or low ambient temperatures and high altitude.

Only specially adapted vehicles (FFV - Flexible Fuel Vehicles) can run on high alcohol fuel blends. BMW, for the various technical and environmental reasons explained below, does not offer FFV models.

Usage of E85 or any other high-alcohol content blend (e.g., E30) in BMW vehicles will cause various drivability complaints (cold-start problems, stalling, reduced performance, poor fuel economy, etc.); may cause excessive emissions; and may cause irreversible damage to engine, emission control and fuel delivery systems due to incompatibility of materials with alcohols.

General Notes Regarding E85 Fuel

E85 fuel contains 85% (by volume) ethanol and 15% gasoline. Ethanol can be produced chemically from ethylene or biologically from grains, agricultural wastes, or any organic material containing starch or sugar. In the US, ethanol is mainly produced from corn and is classified as a renewable fuel.

Similar to gasoline, ethanol contains hydrogen and carbon with additional oxygen molecules built into its chemical chain. This chemical structure makes ethanol's burning process slightly cleaner than gasoline (lower tailpipe emissions).

On the other hand, due to lower carbon content, ethanol provides 27% less energy (for identical volume) than gasoline, resulting in reduced fuel economy of E85 vehicles (approximately 22% higher consumption). Increased fuel consumption requires appropriately enlarged fuel tank capacities (usually a 30% increase), and specific DME calibrations for E85 lower stoichiometric air/fuel ratio (10 compared to 14.7 for gasoline engines).

E85 fuel volatility is typically lower than gasoline (RVP 6-10 psi, compared to 8-15 psi for gasoline). Lower fuel volatility will reduce vehicle evaporative emissions, but it may cause cold-starting problems, especially with lower ambient temperatures.

Under certain environmental conditions, mainly lower ambient temperatures, ethanol separates from the gasoline/alcohol mixture and absorbs water. The ethanol-absorbed water molecules are heavier than gasoline or ethanol; they remain at the bottom of fuel tank and, when introduced into the combustion process, they tend to form an extremely lean mixture resulting in misfire, rough idle and cold-starting problems.

Certain materials commonly used with gasoline are totally incompatible with alcohols. When these materials come in contact with ethanol, they may dissolve in the fuel, which may damage engine components and may result in poor vehicle drivability.

Some metals (e.g., zinc, brass, lead, aluminum) become degraded by long exposure to ethanol fuel blends. Also, some nonmetallic materials used in the automotive industry such as natural rubber, polyurethane, cork gasket material, leather, polyvinyl chloride (PVC), polyamides, methyl-methacrylate plastics, and certain thermo and thermoset plastics degrade when in contact with fuel ethanol.

In order to safely and effectively operate a motor vehicle running on E85, the vehicle must be compatible with alcohol use. Some manufacturers have developed vehicles called FFV (Flexible Fuel Vehicle) that can operate on any blend of ethanol and gasoline (from 0% ethanol and 100% gasoline to 85% ethanol and 15% gasoline). Ethanol FFVs are similar to gasoline vehicles, with main differences in materials used in fuel management and delivery systems, and DME control module calibrations. In some cases, E85 vehicles also require special lubricating oils.

Aftermarket conversions of gasoline-powered vehicles to ethanol-fueled vehicles, although possible, are not recommended, due to internal materials and DME software incompatibility as well as the high costs of conversion.

In order to correctly diagnose various drivability complaints caused by fuel blends with a high level of ethanol content, refer to SI B13 05 10, Testing Fuel Composition for applicable tools and procedures.

WARRANTY INFORMATION

Components damage/malfunctions or any drivability problems caused by the use of fuels containing more than 10% ethanol (or other oxygenates with more than 2.8% oxygen by weight) will not be covered under BMW warranties with respect to defects in materials or workmanship.

Mercedes-Benz

Mercedes-Benz USA, LLC
Ernst H. Lieb
President and CEO

June 10, 2011

The Honorable F. James Sensenbrenner, Jr.
2449 Rayburn House Office Building
Washington, DC 20515-4905

Dear Congressman Sensenbrenner:

Thank you for your letter regarding the Environmental Protection Agency's (EPA) decision to approve E15 for use in cars and trucks of Model Year 2001 or later. I appreciate the opportunity to respond to your inquiry.

Biofuels play an important part in strengthening our nation's energy security. But, like you, I am concerned over the EPA's decision to grant a waiver for E15 use in certain model year cars and trucks. A premature introduction of E15 into the marketplace will heighten consumer confusion and undercut studies already underway that aim to evaluate the effects of increased ethanol blends on vehicle parts and systems.

As you may know, numerous organizations across the United States have commented on the EPA's decision. Automakers are not alone in voicing their opposition. Among others, the auto industry is joined by organizations representing agriculture, small engine manufacturers, and small business owners in uniformly opposing this premature decision on ethanol.

Throughout its operations in the U.S., Mercedes-Benz has provided the most advanced engine and emission control systems to meet the requirements of the U.S. market. All current Mercedes-Benz fleet vehicles and series model lines up to MY 2011 are designed and tested for the use of E10. We have relied on this E10 blend wall in our vehicle design, and any ethanol blend above E10, including E15, will harm emissions control systems in Mercedes-Benz engines, leading to significant problems with certification, in-use testing, emissions performance and fuel economy.

Mercedes-Benz customers who misfuel with E15 will force the Company to face a host of product liability actions. Although the Mercedes-Benz warranty in the owner's manual is clearly restricted to claims involving "proper maintenance," it would be impossible for the Company to prove that the vehicle damage is due to customer misfueling.

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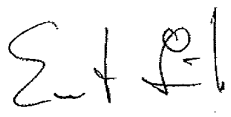
The deterioration, early wear, and aging process depend on how much and how often customers misfuel. Thus, Mercedes-Benz and other manufacturers will be forced into legal actions at a serious disadvantage.

More information on the compatibility of higher ethanol blends in vehicles must be obtained—we simply need more research on the possible negative effects this could have on engines and vehicle components.

At Mercedes-Benz, consumer satisfaction is paramount. Anything that might jeopardize our customer's perception of quality, performance, and safety of a Mercedes vehicle is of deep concern. For this reason, we have steadfastly opposed the EPA's decision to increase ethanol blends without full, comprehensive study. I am pleased that auto manufacturers have been joined by dozens of other associations and industries in voicing similar objections.

Congressman, thank you for your leadership on this issue. Again, thank you for contacting me.

Sincerely,



TOYOTA

TOYOTA MOTOR NORTH AMERICA, INC.

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June 13, 2011

The Honorable F. James Sensenbrenner, Jr.
Vice Chairman
House Committee on Science, Space, and Technology
Room 2449 Rayburn House Office Building
Washington, DC 20515

Dear Vice Chairman Sensenbrenner:

I am writing in response to your June 1, 2011 letter to James Lentz concerning the Environmental Protection Agency's (EPA's) approval of E15 for use in 2001 model year and later vehicles.

Toyota strongly supports the development of alternative fuels to help reduce dependence on foreign oil and potentially reduce vehicle emissions. However, along with many other automobile manufacturers, Toyota is concerned about the EPA waivers approving use of E15 for 2001 model year and newer vehicles. As you may know, Toyota is a member of the Alliance of Automobile Manufacturers and the Association of Global Automakers, and these trade associations have joined with the National Marine Manufacturer's Association and the Outdoor Power Equipment Industries to challenge EPA's E15 waiver decisions.

Listed below are the questions from your letter along with Toyota's response:

1) Are you confident that your cars and trucks from model year 2001 and later will not be damaged by or wear more quickly from use of E15?

   RESPONSE: With the exception of the Flexible Fuel Vehicle (FFV) versions of our Tundra and Sequoia (which were designed specifically for the higher ethanol-based fuel), all Toyota, Lexus and Scion models on the road today have only been designed for fuels with up to 10% ethanol (E10). Moving from E10 to E15 represents a 50% increase in the alcohol content of the fuel compared to what the vehicles were designed to accept. Unfortunately, the data considered in connection with EPA's E15 waivers does not adequately determine the effect of this change on Toyota's legacy fleet. Accordingly, Toyota cannot recommend the use of fuel with greater than E10 (10% ethanol) for Toyota vehicles currently on the road, except for the FFV's.

2) Will your current warranty cover potential problems stemming from the use of E15 in cars and trucks from model year 2001 and later?

RESPONSE: The vehicle owner's manual for Toyota, Lexus and Scion vehicles clearly recommends against using fuels with ethanol content greater than 10%, except for the FFV's, which can use fuels up to 85% ethanol. Our policy remains that we will not provide warranty coverage for issues arising from the misuse of fuels that exceed specified limits.

3) Will E15 affect the fuel efficiency of your engines?

RESPONSE: Because a gallon of ethanol has lower energy content than a gallon of gasoline, higher level ethanol blends will generally result in lower real-world vehicle fuel economy.

Toyota recognizes that ethanol and other renewable fuels will continue to play an important role in US energy policy. But, rather than pursue a *retrospective* solution that carries substantial risks for consumers, automakers, equipment makers and fuel providers, we need a *prospective* solution that provides adequate lead time for vehicle development, fueling infrastructure modifications and misfueling prevention measures. In support of this notion, and to avoid a continually moving target, Toyota stands ready and willing to develop E20 compatible vehicles in the future provided these issues are addressed.

We welcome the opportunity to work with key stakeholders in Congress, the regulatory agencies, the auto industry, the fuel industry and others to examine a practical pathway forward. Please contact me if you have any questions or need any additional information.

Sincerely,

Thomas J. Lehner
Vice President, Government & Industry Affairs
Toyota Motor North America

VOLKSWAGEN

GROUP OF AMERICA

MICHAEL LOHSCHELLER
EXECUTIVE VICE PRESIDENT &
CHIEF FINANCIAL OFFICER

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June 9, 2011

The Honorable F. James Sensenbrenner, Jr.
Vice-Chairman, House Committee on Science, Space, and Technology
U.S. House of Representatives
2449 Rayburn House Office Building
Washington, D.C. 20515-4905

Dear Congressman Sensenbrenner,

Thank you for your June 1 letter to Jon Browning inquiring about Volkswagen Group of America's position on EPA's decision to allow E15 for use in cars and trucks of model year 2001 or later. Mr. Browning is out of the country and has asked that I respond on his behalf. We appreciate your leadership on this issue and support your legislation to block the implementation of this rule. Below please find our responses to your questions.

1. Are you confident that your cars and trucks from model year 2001 and later will not be damaged by or wear more quickly from use of E15?

Volkswagen does not have complete confidence that our vehicles will have no problems related to the use of E15. During the development of existing products no manufacturer tested for E15, since this fuel was not considered as a possible fuel when these vehicles were designed and tested. There is risk that a population of these existing vehicles could experience some type of problem due to E15.

Volkswagen agrees that the EPA did not conduct an adequate test program when E15 was considered and then approved for use in conventional vehicles. The auto and petroleum industry, through the CRC organization, conducted some limited testing of five vehicle areas where it was felt E15 could cause problems with some population of 2001 and newer vehicles. These five areas of concern are the following: base engine durability, catalyst durability, fuel system components, evaporative emissions systems and on board diagnostic (OBD) systems. The CRC testing indicated that some vehicles may be subject to problems related to E15 in the areas mentioned. It is possible that Volkswagen vehicles are included in the population of vehicles that could experience problems.

RESPONSE: The vehicle owner's manual for Toyota, Lexus and Scion vehicles clearly recommends against using fuels with ethanol content greater than 10%, except for the FFV's, which can use fuels up to 85% ethanol. Our policy remains that we will not provide warranty coverage for issues arising from the misuse of fuels that exceed specified limits.

3) Will E15 affect the fuel efficiency of your engines?

RESPONSE: Because a gallon of ethanol has lower energy content than a gallon of gasoline, higher level ethanol blends will generally result in lower real-world vehicle fuel economy.

Toyota recognizes that ethanol and other renewable fuels will continue to play an important role in US energy policy. But, rather than pursue a *retrospective* solution that carries substantial risks for consumers, automakers, equipment makers and fuel providers, we need a *prospective* solution that provides adequate lead time for vehicle development, fueling infrastructure modifications and misfueling prevention measures. In support of this notion, and to avoid a continually moving target, Toyota stands ready and willing to develop E20 compatible vehicles in the future provided these issues are addressed.

We welcome the opportunity to work with key stakeholders in Congress, the regulatory agencies, the auto industry, the fuel industry and others to examine a practical pathway forward. Please contact me if you have any questions or need any additional information.

Sincerely,

Thomas J. Lehner
Vice President, Government & Industry Affairs
Toyota Motor North America

VOLVO
Volvo Car Corporation

The Honorable F. James Sensenbrenner, Jr., Vice-Chairman
House Committee on Science, Space, and Technology
Room 2449
Rayburn House Office Building
Washington, DC 20515-4905

Date	Telephone (call/fax)	Telefax	Our reference
2011-06-02			

Dear Vice-Chairman Sensenbrenner:

In response to your letter of June 1, 2011 regarding possible concerns of Volvo Car Corporation (VCC) and other constituents about EPA's recent approval of a blend of 15 percent ethanol (E15) for use in cars and trucks of Model Year 2001 or later, Volvo would like to offer the following answers to the questions posed in your letter.

1. Damage or wear from the use of E15 in model year 2001 and later Volvo vehicles: Volvo would expect accelerated engine wear and reduced durability over the lifetime of any vehicle engine subjected to E15 use. Field studies done at markets with rising blends above E10 has shown signs of premature ageing of rubber components in the fuel distribution system, which poses an increased risk regarding evaporative emissions. Volvo vehicles currently meet evaporative and exhaust emission performance and durability requirements using fuel containing not more than 10 percent ethanol (E10). While wear and tear at the federal useful life standard of 10 years/120,000 miles would already be concerning, California's Zero Emission Vehicle useful life standard of 15 years/150,000 miles would pose an even greater concern.

   Volvo currently markets modified variants that can handle higher levels of ethanol than E10 in some markets
   - Volvo has not currently scheduled to include variants in the U.S. market that can cope with higher ethanol concentrations than 10%
   - We can not modify already produced cars to minimize the risk of the described customer and environmental problems.

2. Warranty coverage of potential problems stemming from the use of E15: Volvo owner's manual specifies a maximum 10 percent allowable ethanol content. The owner's manual also stresses the importance of proper vehicle care and maintenance, including the use of approved fuels, fluids, and lubricants.

Volvo's warranty, spelled out in a Warranty and Maintenance Records Information booklet, reserves the right to deny warranty coverage for damage caused by or under limited but specific circumstances, which expressly include:

"The use of fuel and/or oil, or other fluids which do not meet the Volvo-approved standards as set forth in the Owner's Manual, Volvo Service Literature or [in this] booklet."

However, it must also be understood that federal law puts the burden on the manufacturer to prove cause of emission failure. Therefore, any manufacturer would be prevented from arbitrarily assigning blame to the use of E15; such a determination must be supported by evidence. That kind of evidence can be elusive, given the uncertainty of histories of use of most motor vehicles.

3. E15's effect on vehicle fuel consumption: Ethanol contains less energy than gasoline. E10 already causes an increase in fuel consumption over unblended fuel. Volvo estimates that an increase in ethanol to 15 percent will degrade fuel economy and increase fuel consumption by a further 2.5 percent.

4. E15, an environmental aspect

Bringing a higher content of ethanol in the existing fuel market can be an opportunity to introduce alternative fuels. If focusing on the environmental aspect, the introduction of alternative fuels is in general a multistep process, the impact on the source of fuel and how it used.
Important environmental benefit is a reduction of the use of fossil fuels and replacing it with renewable fuel. In other words, it affects the CO2 balance positively.
The low-blend of ethanol, E10 and E15, causes fuel consumption to increase as described in paragraph 3 but CO2 emissions are expected to be unchanged or better when used. According to Volvo's calculations, CO2 emissions from E15 will be roughly equivalent to E10.

In this case, where the E15 is made available for all passenger car types from MY2001 designed to E10 but not E15, arises an environmental dilemma. The benefits when you utilize E10 to E15 to reduce CO2 the effect does not occur, it remains unchanged.
As described in paragraph 1, it is Volvo's engineering assessment that there is a likelihood of accelerated engine wear and rubber fuel system components are most likely to age prematurely, thus, adding an emission risk with respect to evaporative emissions.

Volvo's summation leads to the conclusion that by introducing the E15 for variants that are designed to E10, will add to the risk associated with respect to emissions while there is

a no significant improvement in CO2 when using E15 instead of E10. Thus arise the conclusion that the risks related to emissions are greater than the benefits in terms of CO2 when using low-blend E15 for variants that are designed to E10. Thank you for considering our views. If you have any questions about the information, please contact Katherine Yehl at kyehl@volvocars.com or (202) 412-5935.

Sincerely,

Doug Speck
President and CEO
Volvo Cars of North America, LLC

HYUNDAI MOTOR COMPANY
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June 30, 2011

The Honorable F. James Sensenbrenner
Vice-Chairman
Committee on Space, Science and Technology
United States House of Representatives
2449 Rayburn House Office Building
Washington, DC 20515-4905

Dear Vice-Chairman Sensenbrenner:

Thank you for your June 1, 2011 letter to John Krafcik, President, Hyundai Motor America ("Hyundai") regarding the Environmental Protection Agency's (EPA) partial waiver decisions permitting the use of gasoline blended with up to 15 percent ethanol (E15) in 2001 model year (MY) and newer passenger cars and light-duty trucks.

Hyundai recommends that before any new fuel is introduced into the marketplace, comprehensive, independent and objective scientific testing be completed to show that the fuel will not increase air pollution, harm engines, or endanger consumers. Further, Hyundai recommends the establishment of adequate protections to prevent misfueling.

Your letter asks for responses to several questions regarding E15. The questions and Hyundai's responses are shown below.

1. Are you confident that your cars and trucks from model year 2001 and later will not be damaged by or wear more quickly for use of E15?

   The EPA tests failed to conclusively show that the vehicles will not be subject to damage or increased wear. Hyundai therefore has no basis to conclude that its vehicles will not be damaged by or wear more quickly due to the use of E15.

2. Will your current warranty cover potential problems stemming from the use of E15 in cars and trucks from model year 2001 and later?

   Hyundai owner's manuals state: "Vehicle damage or drivability problems may not be covered by the manufacturer's warranty if they result from the use of gasohol containing more than 10 percent ethanol..." The manuals also state "Do not use gasohol (gasoline-ethanol mixture) containing more than 10 percent ethanol...".

3. Will E15 affect the fuel efficiency of your engines?

   E15 will negatively affect the fuel efficiency of Hyundai engines because ethanol has lower energy content than gasoline.

Thank you for the opportunity to share our recommendations and to respond to your questions. If you have any questions about this information, please me at kmhennessey@hyundai-dc.com or at 202-296-5550.

Sincerely,

Kathleen M. Hennessey
Vice President – Government Affairs

cc: The Honorable Ralph Hall
Chairman, Committee on Science, Space and Technology

The Honorable Eddie Bernice Johnson
Ranking Member, Committee on Science, Space and Technology

John Krafcik
President, Hyundai Motor America

NISSAN

Andrew J. Tavi
VP Legal and Government Affairs,
and General Counsel

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June 17, 2011

The Honorable F. James Sensenbrenner, Jr.
Vice Chairman
House Committee on Science, Space and Technology
United States House of Representatives
2449 Rayburn House Office Building
Washington, DC 20515-4905

Dear Vice Chairman Sensenbrenner:

We appreciate receiving your letter dated June 1, 2011 regarding EPA's two partial waiver decisions that permit the sale of gasoline containing up to 15 percent ethanol (E15) for 2001 model year (MY) and newer passenger cars and light trucks. We believe that increasing the allowable ethanol content in gasoline by 50 percent will have unintended consequences for auto manufactures, consumers, fuel suppliers and distributors. Nissan's primary concern about these E15 waivers is the overriding need for consumer safety and satisfaction.

Specifically, your letter asks for responses to the following three questions. Our responses are provided below.

1. **Are you confident that your cars and trucks from model year 2001 and later will not be damaged by or wear more quickly from use of E15?**

   No, we are not at all confident that there will not be damage to MY 2001 and later vehicles that are fueled with E15. In our view the record fails to demonstrate that motor vehicles (other than FFVs) would not be damaged and result in failures when run on E15.

2. **Will your current warranty cover potential problems stemming from the use of E15 in cars and trucks from model year 2001 and later?**

   No. Nissan vehicles covered by the waiver were designed to use a maximum of E10. The direction in the owner manuals of Nissan vehicles reflects the fact that they were not designed to run on E15. EPA regulations allow manufactures to deny warranty coverage for vehicles damaged due to mis-fueling (based on the owner's manual instructions). We are encouraging Nissan vehicle owners to continue to consult their owner's manuals for information regarding the appropriate fuel for the vehicles.

3. **Will E15 affect the fuel efficiency of your engines?**

   Yes. A gallon of ethanol has lower energy content than a gallon of gasoline. Therefore, any increase in ethanol content will necessarily degrade fuel economy.

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Thank you for considering our views. If you have any questions about this information, Please contact Tracy Woodard at tracy.woodard@nissan-usa.com or 615-725-2377.

Sincerely,

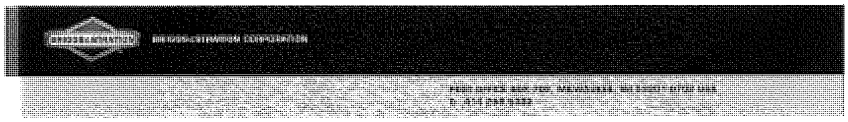


Andrew J. Tavi
Vice President, Legal and Government Affairs,
and General Counsel

CC: The Honorable Ralph Hall
Chairman, Committee on Science, Space and Technology

The Honorable Eddie Bernice Johnson
Ranking Member, Committee on Science, Space and Technology

LETTERS TO REPRESENTATIVE F. JAMES SENSENBRENNER, JR., FROM BRIGGS & STRATTON, SUBARU, GENERAL MOTORS, AND MERCURY MARINE



June 30, 2011

Congressman F. James Sensenbrenner, Jr.

Congress of the United States

House of Representatives

2449 Rayburn House Office Building

Washington, D.C. 20515-4905

Dear Congressman Sensenbrenner;

Thank you for your review of the ethanol issue as part of your work on the House Committee on Science, Space and Technology. We support the continued inquiry into EPA's activities related to ethanol and specifically the implementation issues associated with EPA's Partial Waiver of Growth Energy's E15 Petition.

Further, we believe that the driving force behind increased ethanol use should be re-evaluated (i.e. the RSF-2 blend wall dictated by the Energy and Independence and Security Act of 2007). While we certainly support the broad goals and objectives of the EISA, including the development of alternative fuels and technology, the fuel volume requirements are simply not practical and, we fear, will result in significant investment in short-term/interim alternatives that will preclude the development of long term, sustainable solutions. We urge you, and the Committee, to conduct an inquiry into the fuel volume requirements of the EISA.

Your specific questions and our responses to them are detailed below.

1. Are you confident that the EPA has taken the appropriate steps to prevent E15 from being mistakenly used in non-approved small engines?

Quite to the contrary, we are confident that EPA's proposed mis-fueling regulation will not prevent E15 from being mistakenly used in non-approved small engines. We believe that a number of additional actions need to be taken including ensuring the continued availability of E10, preventing states from adopting legislation that recognizes or promotes ethanol blends different from those approved by EPA, improving the effectiveness of the label design recently approved by EPA, and implementing an enforcement program to ensure compliance with EPA's mis-fueling regulation. The mere addition of a label to the pump will do nothing to prevent mis-fueling without the guarantee that consumers will have convenient access to the proper fuel. Further, the addition of a label in and of itself is insufficient to prevent mis-fueling. The label must be designed to clearly communicate the consequences of mis-fueling to consumers and compliance with the regulation

must be consistently monitored and enforced to be effective. We do not believe that the "balancing of interests" approach propounded by EPA in the issuance of the Final Rule is either legally sufficient or will practically achieve the stated objectives. At a minimum, a human factors analysis of alternative designs should have been conducted as part of the rulemaking. For your convenience I have attached the January 3, 2011 Comments of the Engine Manufacturers Association (EMA) on EPA's NPRM, which provides more specific detail on our concerns (Exhibit 1), many of which were unfairly summarily dismissed by EPA.

2. If E15 is used in your engines, are you confident that it will not cause engine damage?
3. What problems could result from using E15 in your company's engines?

The increased alcohol content of E15 will cause damage to our engines as currently designed and manufactured, the extent of the damage will vary from engine to engine. Ethanol is not substantially similar to gasoline. Increasing the percentage of ethanol blends greater than ten percent (10%) requires a very costly redesign of small off road engines and/or their components and will negatively impact existing products by damaging the engine, reducing overall fuel efficiency and causing engine performance issues. Of note, we estimate there are approximately 100 million Briggs & Stratton engines in the marketplace that will fail prematurely.

Small engines are not designed to operate on a wide range of ethanol blends due to the nature of their fixed calibration carburetor control system. Small engines do not have the on-board engine management systems required to operate on fuels with a range of alcohol content. Some of the highest annual volume production products in the small engine category routinely sell at a lower retail price for the finished product than the incremental cost to implement flexible fuel technologies. Using fuels with higher than 10% alcohol on existing engines will cause the engines to run "lean" resulting in performance issues such as hard starting, engine surging and hunting as well as higher operating temperatures. The higher temperatures will result in reduced engine durability due to premature failure of components such as head gaskets, valves, bearings, and cylinder bores. In addition, there are potential safety issues for the user due to increased operating temperatures and unexpected changes related to the performance or function of the products.

Ethanol is hydroscopic, meaning it absorbs water. The water cannot only cause the engine to run poorly, it can also cause corrosion of commonly used metals such as aluminum and brass. The water itself will cause components to corrode through a variety of means such as acidic attack, galvanic activity, and chemical interaction. In addition, the corrosion particles themselves can clog fuel filters, fuel systems, and damage engine components. The corrosion of various components also reduces the storage life of the fuel resulting in varnish formation, which can result in significant engine performance issues particularly in the carburetor by clogging jets, floats, needles, and seats.

The solvent nature of ethanol adversely affects plastic and rubber, all used as components in small engines. The distortion of plastics and rubber used in seals, gaskets and caps leads to swelling and warping, which results in leakage from fuel system components. In addition, the solvent nature of

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alcohol will affect legacy product by dissolving varnish/gum built up from years of use in the field. The end result is debris being released to sensitive areas of the engine, such as carburetor jets, causing clogging and subsequent performance problems.

Ethanol contains less energy than gasoline and, as a result, increasing the ethanol content of the fuel will proportionally increase the fuel consumption (decrease fuel economy). Consistent with the automotive experience, our tests have demonstrated an increase in fuel consumption with increasing alcohol content. For instance, we expect a 10% fuel consumption penalty (lower fuel economy) using an E20 blend commensurate with a carburetor re-calibration.

For your convenience I am also attaching a copy of EMA's Technical Statement on the effects of ethanol on small engines which provides a detailed description of the effects (Exhibit 2).

4. Will your current warranties cover problems that may arise from the use of E15?

Our current warranty specifically excludes coverage of problems that arise from the use of non-approved fuels such as E15. For your convenience I am attaching a copy of the warranty statement (Exhibit 3, refer to exclusion number 11).

Again, we appreciate your efforts and those of the House Committee to investigate the ethanol issue. If you have any further questions please do not hesitate to contact me.

Sincerely,

Briggs & Stratton Corporation

Todd J. Teske

President, Chairman of the Board and CEO



June 23, 2011

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The Honorable F. James Sensenbrenner, Jr.
Vice-Chairman, House Committee on Science, Space and Technology
United States House of Representatives
Room 2449 Rayburn House Office Building
Washington, D.C. 20515-4905

Dear Vice-Chairman Sensenbrenner,

This is in response to your letter dated June 1, 2011 regarding EPA's partial waiver decisions that would allow E 15 gasoline (gasoline containing 15% ethanol) to be sold and used in vehicles manufactured from the 2001 and newer model years. We thank you for the opportunity to respond to your questions on this topic which would affect our customers, their vehicles and our company.

With the proposed additional increase in ethanol (up 50% from existing allowable) to 15%, we believe that negative consequences will result. Subaru wants to be sure that any change would not adversely affect the safety, drivability and emissions of our vehicles as well as customer's satisfaction.

The specific questions you have asked are repeated below along with our responses. .

1. **Are you confident that your cars and trucks from model year 2001 and later will not be damaged by or wear more quickly from use of E15?**

No, we are not confident that our 2001 model year or later vehicles will not be damaged by the use of E15 in them. Since no Subaru models were included in the testing that had been conducted to support EPA's decision, there is no evidence that our vehicles would not be damaged or continue to be reliable as originally designed.

2. Will your current warranty cover potential problems stemming from the use of E15 in cars and trucks from model year 2001 and later?

No. Subaru vehicles designed and manufactured in the 2001 or later timeframe, were constructed to use up to a 10% ethanol mix (E10). Customers are instructed that for proper operation of their vehicles that no more that 10% ethanol fuel should be used. It is stated in the owner's manual that fuel system damage or drivability problems which result from the use of improper fuel are not covered under the Subaru limited warranty.

3. Will E15 affect the fuel efficiency of your engines?

Yes, since the energy content is less in ethanol, when blended with gasoline the net effect is a lower energy concentrated mixture, so comparatively more fuel would be required for the equivalent amount of work.

I hope our responses are helpful. Should you have any further questions, please contact Maurice Arcangeli at 856-488-3115 marcangeli@subaru.com .

Sincerely,

Subaru of America, Inc.

Thomas J. Doll
Executive Vice President & COO



Robert E. Ferguson
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Via Fax: 202-225-3190

July 6, 2011

The Honorable F. James Sensenbrenner, Jr.
United States House of Representatives
2449 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Sensenbrenner:

Thank you for your letter of June 1, 2011, to General Motors Chairman and CEO, Dan Akerson, regarding EPA's recent approval of a partial waiver for use of E15 in light duty cars and trucks for model years 2001 and later. The questions that you raise in your letter are certainly timely and important.

General Motors, as part of the Alliance of Automobile Manufacturers, has commented extensively to EPA on the potential adverse effects of increasing ethanol content in gasoline by 50% and allowing its use in vehicles not designed for its use. In addition to the concerns expressed in our specific responses to your questions regarding the 2001 and newer model year products provided below, we are very concerned about the possibility of mis-fueling in pre-2001 vehicles and our marine products in contravention of EPA intentions and regulations. It is clear to us, as it is to others, that the controls envisioned by EPA will not prevent such mis-fueling situations from occurring.

With regard to the specific questions raised in your letter, the following are our specific responses:

1. Are you confident that your cars and trucks from model year 2001 and later will not be damaged by or wear more quickly from the use of E15? **Response:** No, we are not confident that our cars and trucks from model year 2001 and later will be undamaged by the use of E15 nor are we confident that they will not wear more quickly from the use of E15. As Administrator Jackson made clear in her remarks, EPA's analysis focused on the effects of E15 on emissions systems rather than overall durability. GM, along with many others, encouraged EPA to wait for on-going testing to be completed prior to making a decision on the E15 waiver request.

The Coordinating Research Council (CRC)* is managing several on-going tests. One of these has documented deterioration in engine valve sealing in late model vehicles as a result of E15 and E20 usage. This deterioration was expected to a degree, because modifications were made to these components for use in vehicles designed to operate on E85. Some proportion of vehicle engines that were not designed for E85 use are likely to prove sensitive to increased ethanol levels and the CRC testing is finding that to be the case.

Another CRC test program has discovered anomalous performance of tank fuel system components. Again, many of these components are upgraded for ethanol tolerance on Flexfuel vehicles. A program to follow-up these screening tests is now being started to develop statistical data.

CRC testing also predicts an increase in vehicle performance problems that will trigger illumination of the vehicle Malfunction Indicator Light (MIL) as a result of increased ethanol in the fuel. This malfunction would not represent a real vehicle fault and the correction would be a return to the recommended fuel. Concerns have been raised with the EPA by the New York Department of Environmental Quality, among others, about how these false MILs would affect driver's response to illuminated MILs and the state inspection and maintenance programs that rely on these signals. Further testing to confirm this result is on-going.

There are five CRC test programs on-going. Three of these, Base Engine Durability, On-Board Diagnostics (OBD) Evaluation, and Vehicle Fuel Systems Durability, are expected to finish in 2011. The other two, Evaporative Emissions Durability and Emissions Inventory and Air Quality Modeling, are expected to complete in 2012. These are lengthy test programs because durability effects over a substantial portion of a vehicle's like cannot be evaluated quickly nor without rigorous vehicle testing.

2. Will your current warranty cover the potential problems stemming from the use of E15 in cars and trucks from model year 2001 and later? **Response:** Our current owner's manuals instruct owners not to use fuel containing more than 10% ethanol unless they are FlexFuel vehicles. Not following these instructions would constitute mis-fueling. Vehicle damage attributed to mis-fueling would not be covered under the new vehicle warranty.

3. Will E15 affect the fuel efficiency of your engines? **Response:** The increased ethanol content will affect vehicle volumetric fuel economy (MPG), which is what our customers are most concerned about. Ethanol has only two thirds the volumetric energy content of gasoline. Adding 5% ethanol to E10, making E15, should reduce vehicle volumetric fuel economy by approximately 1.7%. This would make a total reduction relative to gasoline of approximately 5.1%. DOE testing cited by EPA in its E15 waiver has extensively documented fuel economy losses that match these theoretical predictions.

We hope these answers help frame the issues that still need to be fully addressed in evaluating the appropriateness of EPA granting an E15 waiver. Thank you for inquiring about these important issues.

Sincerely,

Robert E. Ferguson

* http://www.crcao.org/about/index.html ,
http://www.crcao.org/news/Mid%20Level%20Ethanol%20program/index.html

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June 30, 2011

Congressman F. James Sensenbrenner
2449 Rayburn House Office Building
Washington, DC 20515

Sent via fax 202-225-3190

Dear Congressman Sensenbrenner,

I am writing in response to your note to Mark Schwabero dated June 22, 2011.

Thank you for your actions to block the EPA's authority to increase ethanol blends beyond 10 percent. We share your concerns about the lack of testing of higher ethanol blends on fuel systems and engines and we believe that an increase of ethanol concentration in gasoline to 15% (or higher) can have potentially catastrophic effects on engines designed, tested, calibrated and manufactured for a 10% (or lower) concentration of ethanol.

While Mercury supports the goal of reducing our dependence on foreign oil, like other engine manufacturers, we are concerned about the drive for higher concentrations of ethanol in fuel. Ethanol blends greater than 10% are not compatible with engine and fuel system components which have the potential to impair engine performance and compromise operator safety. The use of blending pumps introduces the potential for misfueling and unintended ethanol use – particularly in small portable tanks due to the inability to purge the blend from the pervious user.

With respect to your work on the House Committee on Science, Space and Technology, I've attached a copy of the material that Mercury Marine provided to the U.S. Environmental Protection Agency regarding the waiver application to increase the allowable ethanol content of gasoline to 15%. This material was presented in May 2009 and I've taken the liberty to highlight the sections that specifically relate to your questions and our mutual concerns.

In a related area, and in support of the goal of reducing dependence on foreign oil, Mercury is working closely with industry leaders on blends of Butanol that offer a far improved environmental footprint and leverage the same feedstocks and capacity without the performance or safety concerns associated with ethanol in the 17 million boat legacy fleet.

Thanks again for your support of our concerns in this area. We would be happy to work with you and your committee to further clarify our issues and concerns.

Sincerely,

Kevin S. Grodzki
President Sales, Marketing & Commercial Operations
Mercury Marine

cc: Matt Bisenius (matt.bisenius@mail.house.gov)
Mark Schwabero

Mercury Marine Comments to the U.S. Environmental Protection Agency Regarding the Waiver Application to Increase the Allowable Ethanol Content of Gasoline to 15 Percent
[Docket ID No. EPA-HQ-OAR-2009-0211]

Mercury Marine, a division of Brunswick Corporation, is submitting these comments with regard to the Waiver application made by Growth Energy and 54 ethanol manufacturers.

Mercury Marine is the largest manufacturer of spark-ignited marine engines in the world, and is a division of Brunswick Corporation, the largest manufacturer of recreational boats in the world. As such, Mercury, and Brunswick, have a very strong interest in this subject, as our exposure is great, and our customers have millions of our engines out in the field. Mercury Marine and Brunswick believe that the only way that the content of ethanol in gasoline can be raised from the current 10 percent maximum to any value above that, is with a comprehensive test program that evaluates the effects on both engines and boat fuel systems on current and legacy products. No such test program has been undertaken at this time. With no results of a comprehensive test program to guide EPA's decision, Mercury Marine and Brunswick strongly urge EPA to deny the Waiver.

Recreational Marine has the oldest legacy fleet, and the largest number of engine technologies, of any engine category defined by EPA. There are 17 million recreational boats in America. Boats and engines 30 – 40 years old are still in regular service.

Spark ignited marine engines include the following technologies:

- Carburetor 2-Stroke Outboards - Premix
- Carburetor 2-Stroke Outboards – Oil Injection
- Fuel Injected 2-Stroke Outboards – Oil Injection
- Direct Injected 2-Stroke Outboards – Oil Injection
- Carburetor 4-Stroke Outboards

- Fuel Injected 4-Stroke Outboards
- Fuel Injected, Supercharged, 4-Stroke Outboards
- Carburetor 4-Stroke Inboards/Sterndrives
- Fuel Injected 4-Stroke Inboards/Sterndrives
- Fuel Injected, Supercharged, 4-Stroke Inboards/Sterndrives
- Fuel Injected, Catalytic Converter Equipped, 4-Stroke Inboards/Sterndrives

In addition, marine engines have very high power densities as compactness and weight are critical to keeping the weight of the vessel down to reduce power needs. Finally, marine engines operate on a much more severe duty cycle than on-road vehicle engines. Marine engines must be able to operate for extended periods of time at wide-open-throttle (WOT). Manufacturers test for WOT engine durability routinely since our customers use the product in this manner.

Mercury Marine has seen ethanol related damage and failure even under the current E10 maximum law. Marine engines and boats operate in saltwater, a very corrosive environment. Mercury Marine takes issue with anyone who says that there have been no product problems under the current E10 limits. Problems encountered under the current E10 law include:

- Damage to rubber parts and adhesives
- Water contamination of the fuel system due to Ethanol's hydroscopic nature
- Corrosion of fuel system components due to water contamination
- Higher exhaust gas temperatures due to enleanment (marine engines are almost all open loop and can not compensate for fuel properties)
- Higher NOx emissions on E10 vs. E0.

Mercury Marine believes that a very comprehensive test program must be conducted to determine if there are safety, emissions, or durability problems that would be associated with a higher percentage of ethanol. To that end, Mercury Marine believes that the following tests are required, on both new products and the legacy fleet:

1. **Boat Fuel Systems** – The boat fuel systems consists of fuel tanks, lines, connections, anti-siphon valves, fuel fill, and vent systems. Fuel tanks are routinely made of Aluminum, Fiberglass, and Cross-Linked Polyethylene. Each has its challenges. Documented cases of galvanic corrosion have occurred in Aluminum Tanks, causing fuel leaks in the confined spaces of the boat bilge. This is attributed to the fact that adding ethanol to gasoline makes the fuel conductive. In addition, with ethanol's affinity for water, and the fact that boat fuel systems are vented, significant quantities of water are often present in the fuel, and can lead to phase separation. Also, in a saltwater environment, that water in the fuel system will contain salts, which increase the corrosive effects. Fiberglass tanks have already shown damage/destruction on E10. When the northeast US went from MTBE to E10 a couple years ago, many older boats with fiberglass tanks experienced tank failures. The ethanol dissolved the fiberglass resin and the resulting sludge went into the engines and destroyed them. Further, in many boats, the tanks developed fuel leaks into the confined spaces of the bilge. Most of the repair bills were in the $30,000 - $50,000 range. Keep in mind that a leaking fuel tank in a boat creates an explosive environment due to it being in an enclosed space, with potential ignition sources, which can lead

to injury or death, along with the destruction of the vessel. With the newer cross-linked polyethylene tanks, little is known about long term durability when exposed to higher ethanol blends. The US EPA has recently identified these tanks as being a significant source of evaporative emissions due to permeation and has regulations phasing-in to control permeation. Increased ethanol concentrations will likely increase that permeation rate. Further, the other remaining boat fuel system components (hoses, valves, filler, vent, fuel gauge float and sender, deck plates, etc) need to be evaluated for deterioration from higher ethanol blends.

2. **Engine Fuel Systems** – Most of the older marine engines use carburetors for fuel systems. Marine shops already see carburetor problems associated with the use of E10. These include damaged floats, rubber hoses and parts, gumming and plugging of jets and passageways, etc. Boats are often stored for 5 – 6 months, and many have experienced phase-separation of E10 with absorbed water during storage. Often, the boat will quit running, with no warning. While this is inconvenient in a car, it is dangerous in a boat, as inability to maneuver can lead to accidents, injuries, and death. At the very least, it can lead to costly engine repairs and most of the engines in use are out of warranty, so it is the consumer that gets stuck with the bill. If it is within warranty periods, the engine manufacturer usually pays for the repairs, even though the engine was not at fault. However, we currently allow the use of E10 in our products and stand behind the product on E10. We are not in a position to provide warranty support for products

run on fuels containing higher than 10 percent ethanol and would not be able to until higher ethanol blends have been thoroughly tested, and any required redesign is completed.

3. **Engine Emissions** – While engine emissions are difficult to predict, it is fully expected that there will be an increase in NOx emissions due to lean operation and higher combustion temperatures. The effect on 2 -stroke legacy product is a complete unknown. Engines with higher ethanol content would likely have more water contamination issues that can lead to gumming or corrosion of fuel systems. These will have a negative effect on emissions and appropriate fuel and aging tests will need to be conducted. In addition, valve train wear and valve damage on 4-stroke engines may lead to higher emissions. New inboard and sterndrive engines have three way catalytic converters that are close coupled and will be subjected to higher temperatures. Who pays for the emissions recall if an engine fails an in-use emissions test? The manufacturer developed, certified, and warranted the engine based on the fuel regulations in place at the time the engine was certified.
4. **Engine Durability** – This is one of our greatest concerns. Our current products are calibrated on E0 and tested to insure compatibility with E10. Some of our more recent legacy products were never tested on E10. The older legacy fleet was originally calibrated on leaded gasoline. These engines were stressed when unleaded gasoline became available and further stressed when operated on E10. There is no good data on what

happens when 2-stroke oil is mixed with higher ethanol blends in a 2-stroke engine. Lubricity and combustion stability need to be tested. Lean operation of 2-stroke engines is known to be destructive, primarily to pistons. Oil injected 2-stroke engines may also experience lubricity issues. 4-stroke engines will be subject to much higher exhaust gas temperature and exhaust valve temperatures. A standard outboard engine durability test is to run it for 300 hours at wide open throttle (WOT). This is a very severe test, but is the way our products are often used. For inboard and sterndrive engines, the same test is run for 150 hours.

5. **Power and Drivability** – Any loss of power, acceleration, or drivability is unacceptable in a marine engine. Some boats are powered very close to the level of power required to get the boat on plane. Any loss of acceleration or power could mean that the boat would never achieve planning operation, which would cause an enormous loss of performance and increase in fuel consumption and exhaust emissions, not to mention customer dissatisfaction. Many boats are used for sports activities, including water skiing, wakeboarding, etc, and a loss of power, acceleration, or drivability could render the boat incapable of performing for these activities.

Fuel Availability Considerations

EPA has correctly raised the issue of multiple fuels being available, and the difficulties with restricting certain fuels to certain applications of vehicles and engines. The history of the phase-in of unleaded gasoline was a prime example. This is a very major concern, if a higher ethanol blend were made available for some subset of the vehicle/engine

population. As was the case with leaded gasoline, consumers will often choose the least expensive fuel, whether it is appropriate for their vehicle or not. The additional unknown for a higher ethanol blend is that there will be a difference in fuel economy. One very major misconception that we have heard is that most boats are refueled at marinas. This is blatantly false. Approximately 90% of boats are trailerable, do not sit in slips in marinas, and are refueled at regular automotive gas stations. Most owners put the same gas in their boat that they put in their car or truck. It is common knowledge that very few people read the warning messages posted on most gas pumps. Most boats have very large diameter fuel fill pipes and deck fittings. There is no standard size. Therefore, restricting the use of the wrong fuel via a different size fill nozzle will not work. Mercury Marine can not identify any strategy that will actually prevent unintentional misfueling. Further, we are concerned that, if higher ethanol blends are approved for on-road vehicles, but not nonroad engines, the availability of fuel for nonroad engines could be very difficult due to nonroad engines only using a small percentage of the total fuel usage. If appropriate fuels are not available, inappropriate ones will be used.

EPA has requested specific comment on several specific items. Mercury Marine wishes to respond to those items that are pertinent to our products and customers:

(b) evaluate whether an appropriate level of scientific and technical information exists in order for the Administrator to determine whether the use of E15 will not cause or contribute to a failure of any emission control device or system over the useful life of any nonroad vehicle or nonroad engine (certified pursuant to section 206 and 213(a) of the Act) to achieve compliance with applicable emission standards; and,
(c) evaluate whether an appropriate level of scientific and technical information exists in order for the Administrator to grant a waiver for an ethanol-gasoline blend greater than 10 percent and less than or equal to 15 percent by volume.

Mercury Marine believes there is no credible scientific or technical information to determine whether the use of E15 will not cause or contribute to a failure of any emissions

control device or system over the useful life of marine engines. Further, there is no credible evidence that any increase, over 10 percent ethanol, can be used without damaging or destroying emissions control devices or systems in marine engines. What information exists is mostly anecdotal, and in fact, indicates that problems and failures exist even on E10.

Further, statements by the Governors' Biofuels Coalition that currently available fuels go up to E13 is blatantly false, not supported by EPA's own database, and would be illegal under the current E10 law which allows a **maximum** of 10 percent ethanol.

(d) all legal and technical aspects regarding the possibility that a waiver might be granted, in a conditional or partial manner, such that the use of up to E15 would be restricted to a subset of gasoline vehicles or engines that would be covered by the waiver, while other vehicles or engines would continue using fuels with blends no greater than E10. EPA seeks comment on what measures would be needed to ensure that the fuel covered by the waiver (i.e. a partial or conditional waiver) is only used in that subset of vehicles or engines. EPA acknowledges that the issue of misfueling would be challenging in a situation where a conditional waiver is granted. To the extent a partial or conditional waiver may be appropriate, please provide comments on the legal and technical need for restrictions of this nature. Comments are also requested on how the Agency might define a partial or conditional waiver. For example, assuming there is sufficient technical basis, should the subset of vehicles or engines that is allowed to use the waived fuel be defined by model year of production, engine size, application (e.g., highway vehicle vs. nonroad engine), or some other defining characteristic.

Mercury Marine believes that misfueling, under the terms of a partial waiver, would be virtually impossible to avoid as there is no mechanical means to prevent misfueling. Our owner's manual and literature clearly do not allow fuel containing greater than 10 percent ethanol. We specifically do not cover warranty repairs caused by fuel containing greater than 10 percent ethanol. Between the potential for limited availability of suitable fuels, and the general belief in the public that "what goes in my car, goes in my boat" misfueling will happen. Who pays for the ethanol related failures? It is certainly unfair to the consumer, who does not know or does not understand the issue. To expect the manufacturer to pay for these repairs, when the engine was designed to run on a different fuel than what is being sold, is a

tax on the engine manufacture that we can not afford. In addition, it damages our reputation for building a reliable product because it failed through no fault of our own. Further, the legal implication of requiring a fuel that may not be available to a particular consumer, in their particular area, is not an easy question to answer.

> (e) Any education efforts that would be needed to inform the public about the new fuel that would be available if a waiver is granted. To address the possibility of a grant of a conditional or partial waiver, the Agency requests specific comments on public education measures that would be needed if the waiver allowed the fuel to be used only in a subset of existing vehicles or engines.

Mercury Marine is of the belief that no amount of public information and education can possibly prevent misfueling in the event of a partial waiver. As has been very evident, in recent times, the amount of misinformation in the media is very confusing to the average consumer. Over the years, there have been numerous examples where public education was relied upon, and it did not work. The primary example, cited by EPA, was the introduction of unleaded gasoline. In that situation, a different nozzle size was used, and that did not stop intentional misfueling. Further, the ethanol industry, and ethanol proponents, have been guilty of spreading misinformation and distorting the truth. There were statements made to the press last year that 25 percent ethanol actually would increase the fuel economy in cars designed to run on gasoline. This statement not only did not make sense, due to ethanol's lower energy content, it violates laws of physics. To believe that the ethanol industry would actually educate the public in a fair, unbiased, and non-confusing way would be a difficult leap of faith. Even if that education took place, the American public has a long history of making their own decisions, good or bad.

Summary

Mercury Marine is not against ethanol. Mercury Marine opposes an increase in ethanol, above 10 percent, without a thorough test plan being executed, a thorough game plan being developed for distribution, should it be acceptable in some or all engine/vehicle categories, and addressing the issues of warranty, emissions compliance, and resolution of all issues raised in these and other comments. Mercury Marine has repeatedly offered to conduct a government funded test program for marine engines, utilizing already in-place test facilities and expertise. To date, the Department of Energy has made no funding available for such testing.

Thank you for the opportunity to submit these comments.

ASSOCIATION OF INTERNATIONAL AUTOMOBILE MANUFACTURERS, INC: RESPONSE TO EPA DECISION TO APPROVE E15 ETHANOL FUEL FOR 2001–2006 MY VEHICLES

http://www.globalautomakers.org/media/press-release/2011/01/response-to-epa-decision-to-approve-e15-ethanol-fuel-for-2001-2006-my-ve

Response to EPA Decision to Approve E15 Ethanol Fuel for 2001-2006 MY Vehicles

January 21, 2011

The Association of International Automobile Manufacturers, Inc. (AIAM) is disappointed with today's decision by EPA to expand its partial waiver to 2001-2006 model year vehicles.

AIAM member companies are pioneering technologies to advance the goal of increasing fuel economy and reducing greenhouse gas emissions. We have, and continue to support the use of alternative fuels, including ethanol. However, before any new fuel is introduced into the marketplace for use in current vehicles and engines not warranted or certified for such fuel, we believe comprehensive, independent and objective scientific testing must be completed to show that the fuel will not increase air pollution, harm engines, or endanger consumers and that there are adequate protections to prevent misfueling.

In our view, EPA has prematurely granted the partial waiver, which – if applied at all – should only be imposed prospectively. As part of a coalition of vehicle and engine products associations, AIAM currently is challenging in court EPA's grant of a partial waiver permitting gasoline with E15 for 2007 model year and newer vehicles. We remain committed to continue working with the Administration and other stakeholders on the challenging issues related to the introduction of new fuels into the marketplace.

http://www.autoalliance.org/index.cfm?objectid=3C21853A-2586-11E0-A62C000C296BA163

For Immediate Release

January 21, 2011

ALLIANCE STATEMENT REGARDING EPA DECISION ON E15 FUEL USE

The Alliance is still reviewing the announcement, but we have no reason to believe that EPA has adequately addressed the concerns that the Alliance and others have raised for months now related to the adequacy of testing. Consumers should continue to consult their owners' manuals for information regarding the appropriate fuel for their vehicles.

Any new fuel's success depends on how it's accepted by consumers, and automakers still have concerns on behalf of our customers. We believe more research is needed to determine how increased ethanol levels could affect vehicles that were designed and warranted for E10.

Although we are part of a wide coalition challenging the initial E15 partial waiver decision, we have made no decisions on our response to today's announcement.

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The Alliance of Automobile Manufacturers is a trade association of 12 car and light truck manufacturers including BMW Group, Chrysler, Ford Motor Company, General Motors, Jaguar Land Rover, Mazda, Mercedes-Benz USA, Mitsubishi Motors, Porsche, Toyota, Volkswagen and Volvo. Visit www.autoalliance.org *for more information.*

PREPUBLICATION VERSION
SUBJECT TO FURTHER EDITORIAL REVISION

Renewable Fuel Standard

Potential Economic and Environmental Effects of U.S. Biofuel Policy

Committee on Economic and Environmental Impacts of Increasing Biofuels Production

Board on Agriculture and Natural Resources
Division on Earth and Life Studies

Board on Energy and Environmental Systems
Division on Engineering and Physical Sciences

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In Memoriam

Lester B. Lave
(1939-2011)

The committee dedicates this report to Dr. Lester Lave, chair for the majority of the duration of the study until his passing. Dr. Lave was a supremely accomplished scholar and educator, who conducted work of international significance and dedicated much of his time to National Research Council and Institute of Medicine studies. Dr. Lave was an inspirational leader. He framed complex questions in tractable ways, stimulated productive discussion on critical topics, listened carefully, and provided a strong hand to focus the committee's work. This report and each member of the committee benefited from his commitment to excellence.

Preface

Prediction is very difficult, especially if it's about the future.
– Niels Bohr

In the United States, we have come to depend upon plentiful and inexpensive energy to support our economy and lifestyles. In recent years, many questions have been raised regarding the sustainability of our current pattern of high consumption of nonrenewable energy and its environmental consequences. Further, because the United States imports about 55 percent of the nation's consumption of crude oil, there are additional concerns about the security of supply. Hence, efforts are being made to find alternatives to our current pathway, including greater energy efficiency and use of energy sources that could lower greenhouse gas (GHG) emissions such as nuclear and renewable sources, including solar, wind, geothermal, and biofuels. This study focuses on biofuels and evaluates the economic and environmental consequences of increasing biofuels production. The statement of task asked this committee to provide "a qualitative and quantitative description of biofuels currently produced and projected to be produced by 2022 in the United States under different policy scenarios . . ."

The United States has a long history with biofuels. Recent interest began in the late 1970s with the passage of the National Energy Conservation Policy Act of 1978, which established the first biofuels subsidy, applied in one form or another to corn-grain ethanol since then. The corn-grain ethanol industry grew slowly from the early 1980s to around 2003. From 2003 to 2007, ethanol production grew rapidly as methyl tertiary butyl ether was phased out as a gasoline oxygenate and replaced by ethanol. Interest in providing other incentives for biofuels increased also because of rising oil prices from 2004 and beyond. The Energy Independence and Security Act of 2007 established a new and much larger Renewable Fuels Standard and set in motion the drive towards 35 billion gallons of ethanol-equivalent biofuels plus 1 billion gallons of biodiesel by 2022. This National Research Council committee was asked to evaluate the consequences of such a policy; the nation is on a course charted to achieve a substantial increase in biofuels, and

there are challenging and important questions about the economic and environmental consequences of continuing on this path.

The committee brings together expertise on the many dimensions of the topic. In addition, we called upon numerous experts to provide their perspectives, research conclusions, and insight. Yet, with all the expertise available to us, our clearest conclusion is that there is very high uncertainty in the impacts we were trying to estimate. The uncertainties include essentially all of the drivers of biofuel production and consumption and the complex interactions among those drivers: future crude oil prices, feedstock costs and availability, technological advances in conversion efficiencies, land-use change, government policy, and more. The U.S. Department of Energy projects crude oil price in 2022 to range between $52 and $177 per barrel (in 2009 dollars), a huge range. There are no commercial cellulosic biofuels plants in the United States today. Consequently, we do not know much about growing, harvesting, and storing such feedstocks at scale. We do not know how well the conversion technologies will work nor what they will cost. We do not have generally agreed upon estimates of the environmental or GHG impacts of most biofuels. We do not know how landowners will alter their production strategies. The bottom line is that it simply was not possible to come up with clear quantitative answers to many of the questions. What we tried to do instead is to delineate the sources of the uncertainty, describe what factors are important in understanding the nature of the uncertainty, and provide ranges or conditions under which impacts might play out.

Under these conditions, scientists often use models to help understand what future conditions might be like. In this study, we examined many of the issues using the best models available. Our results by definition carry the assumptions and inherent uncertainties in these models, but we believe they represent the best science and scientific judgment available.

We also examined the potential impacts of various policy alternatives as requested in the statement of work. Biofuels are at the intersection of energy, agricultural, and environmental policies, and policies in each of these areas can be complex. The magnitude of biofuel policy impacts depends on the economic conditions in which the policy plays out, and that economic environment (such as GDP growth and oil price) is highly uncertain. Of necessity, we made the best assumptions we could and evaluated impacts contingent upon those assumptions.

Biofuels are complicated. Biofuels are controversial. There are very strong advocates for and political supporters of biofuels. There are equally strong sentiments against biofuels. Our deliberations as a committee focused on the scientific aspects of biofuel production—social, natural, and technological. Our hope is that the scientific evaluation sheds some light on the heat of the debate, as we have delineated the issues and consequences as we see them, together with all the inherent uncertainty.

Ingrid C. Burke
Wallace E. Tyner
Cochairs, Committee on Economic and Environmental Effects of Increasing Biofuels Production

Acknowledgments

This report is a product of the cooperation and contribution of many people. The members of the committee thank all the speakers who provided briefings to the committee. (Appendix C contains a list of presentations to the committee.) Members also wish to express gratitude to Nathan Parker, University of California, Davis, and Alicia Rosburg, Iowa State University, who provided input to the committee.

This report has been reviewed in draft form by persons chosen for their diverse perspectives and technical expertise in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards of objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

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Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by Dr. Thomas E. Graedel, Yale University, appointed by the Division on Earth and Life Studies, and Dr. M. Granger Morgan, Carnegie Mellon University, appointed by the NRC's Report Review Committee. They were responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

Contents

SUMMARY 1

1 **INTRODUCTION** 13
Interest in Biofuels, 16
Renewable Fuel Standard, 20
Impetus for Study, 24
References, 28

2 **BIOFUEL SUPPLY CHAIN** 33
Food-Based Biofuels, 33
Nonfood-Based Biofuels, 44
Other Feedstocks and Processing Technologies in Development, 74
Conclusion, 75
References, 77

3 **PROJECTED SUPPLY OF CELLULOSIC BIOMASS** 89
Potential Supply of Biofuel Feedstock and Location of Biorefineries, 90
Uncertainties about Cellulosic Feedstock Production and Supply, 109
Conclusion, 110
References, 111

4 **THE ECONOMICS AND ECONOMIC EFFECTS OF BIOFUELS PRODUCTION** 115
Estimating the Potential Price of Cellulosic Biomass, 116
Primary Market and Production Effects of U.S. Biofuels Policy, 135
Effects of Biofuels Production on the Balance of Trade, 159
Budget, Welfare and Social Value Effects of RFS2, 161
Effects of Adjustments to and Interactions with U.S. Biofuel Policy, 182
Conclusion, 191
References, 192

5 **ENVIRONMENTAL EFFECTS AND TRADEOFFS OF BIOFUELS** 201
Life-cycle Approach for Assessing Environmental Effects: An Overview, 202
Greenhouse Gas Emissions, 205
Air Quality, 224
Water Quality, 228
Water Quantity and Consumptive Water Use, 239
Effects on Soil, 251
Biodiversity, 253
Ecosystem Services, 256
Regional and Local Environmental Assessments, 258
Uncertainties about Environmental Effects of Biofuels Production, 266
Opportunities to Minimize Negative Environmental Effects, 267
Conclusion, 269
References, 273

6 **BARRIERS TO ACHIEVING RFS2** 297
Economic Barriers, 398
Policy Barriers, 305
Environmental Barriers, 309
Social Barriers, 312
Conclusions, 316
References, 317

APPENDIXES 325

A STATEMENT OF TASK, 325
B BIOGRAPHICAL SKETCHES, 327
C PRESENTATIONS TO THE COMMITTEE, 333
D GLOSSARY, 337
E SELECT ACRONYMS AND ABBREVIATIONS, 339
F CONVERSION FACTORS, 341
G PETROLEUM-BASED FUEL ECONOMICS, 343
H ETHANOL BIOREFINERIES IN OPERATION OR UNDER CONSTRUCTION IN THE UNITED STATES IN 2010, 351
I BIODIESEL REFINERIES IN THE UNITED STATES IN 2010, 359
J ECONOMIC MODELS USED TO ASSESS THE EFFECTS OF BIOFUELS PRODUCTION IN THE UNITED STATES, 365
K BIOBREAK MODEL ASSUMPTIONS: ASSUMPTIONS FOR WILLINGNESS TO ACCEPT, 369
L BIOBREAK MODEL ASSUMPTIONS, 381
M SUMMARY OF LITERATURE ESTIMATES, 385
N BLEND WALL, 413
O SAFETY AND QUALITY OF BIOFUEL COPRODUCTS AS ANIMAL FEED, 421

List of Tables, Figures, and Boxes

TABLES

S-1 Estimated Unit Price that Biorefineries are Willing to Pay (WTP) for Biofuel Feedstock and Estimated Unit Price that Suppliers are Willing to Accept (WTA) for Cellulosic Biomass when Oil is $111 per Barrel and No Policy Incentives Exist, 26

1-1 History of U.S. Ethanol and Biofuel Legislation, 41
1-2 Equivalence Values Assigned to Renewable Fuels, 42

2-1 Range, Advantages, and Limitations for Commercial Biomass Tree Species in the Southeastern United States, 77
2-2 Ethanol Production from the Iogen Demonstration Facility in Ottawa, Canada, 2005-2010, 87
2-3 Companies that have Secured Funding for Demonstration of Nonfood-Based Biofuel Refineries, 89
2-4 Advanced Biofuel Projects Supported by the U.S. Department of Energy through the American Recovery and Reinvestment Act, 93

3-1 Comparison of Assumptions in Biomass Supply Analyses, 112
3-2 Biomass Feedstocks for Integrated Biorefineries Projected by the NBSM in Selected Regions of the United States, at Prices Sufficient to Meet RFS2 Mandates, 118
3-3 Potential Production of Biomass-Based Diesel, Advanced Biofuels, and Cellulosic Biofuels to Meet RFS2 in Different Regions of the United States as Projected by USDA, 122
3-4 Comparison of Models Used to Estimate Biomass Production by Region and Biorefinery Locations, 129

4-1 BioBreak Simulated Mean WTP, WTA, and Difference Per Dry Ton Without Policy Incentives, 147
4-2 BioBreak Simulated WTA Value Without Policy Incentives by Percentile, 151
4-3 Summary of Economics of Biofuels Conversion, 155
4-4 Estimates of Effect of Biofuel Production on Agricultural Commodity Prices, 2007-2009, 166
4-5 Energy Subsidies, Percent of Consumer Spending on that Source, 189
4-6 Selected Federal Programs to Reduce Production Costs of Cellulosic Biofuel Refineries, 198
4-7 Growth Characteristics of Alternative Timber Types, 212

5-1 Fertilizer Use for Corn and Soybean Production in the United States, 229
5-2 GHG Emissions from Market-Mediated Indirect Land Changes as a Result of Expanding Corn-Grain Ethanol Production in the United States Estimated by Various Authors, 235
5-3 Published Estimates of and Some of the Assumptions Used in Estimating Life-Cycle Greenhouse-Gas Emissions of Corn-Grain Ethanol, 242
5-4 GHG Emissions from Corn-Grain Ethanol Relative to Gasoline as Determined by EPA in its Final Rule for RFS2, 244
5-5 Average Percent Change in Tailpipe Emissions Compared to a Reference Fuels Containing No Ethanol, 247
5-6 Nationwide Emission Inventories for 2022 for RFS1 and RFS2, 250
5-7 Net Change in Flow-Normalized Nitrate Concentration and Flux Between 1980 and 2008, 255
5-8 Application Rates onto Land for Nitrogen, Phosphorus, and Pesticides (and Soil Erosion) as a Result of Growing Corn as Feedstock for Ethanol Production, 257
5-9 Compositional Analysis of Two Ethanol Plant Discharges Adapted from NRC 2008, 260
5-10 Comparison of Water Requirements for Ethanol Production from Corn Grain, Sugarcane, and Other Potential Energy Crops, 266
5-11 Inputs Used for Life-Cycle Analysis of Biofuels Consumptive Water Use in Different Studies, 270
5-12 Embodied Water in Ethanol (EWe) and Total Consumptive Water Use (TCW) in the 19 Ethanol-Producing States in 2007 Ranked According to Each State's Ewe, 271
5-13 Consumptive Water Use over the Life Cycle of Biofuel and Petroleum-Based Fuel Production Estimated by Different Studies, 272

6-1 Complexities of Starch-Based Ethanol Production to Biomass-Based Ethanol Production via Fermentation, 324
6-2 Lifecycle GHG Thresholds Specified in RFS2, 331

FIGURES

S-1 Renewable fuel volume consumption mandated by RFS2, 24

1-1 Structure of the report, 36
1-2 Mandated consumption target under the 2005 Energy Policy Act (EPAct05 RFS) and mandated consumption targets for different categories of biofuels under the 2007 Energy Independence and Security Act (EISA), 43
1-3 Amount of fuel ethanol produced projected by EIA in 2005 (before enactment of EPAct), 2006 (after enactment of EPAct), and 2010 (after enactment of EISA), 45
1-4 Amount of biodiesel produced projected by EIA in 2007 (before enactment of EISA) and 2010 (after enactment of EISA), 45

2-1 Distribution of planted corn acres in the United States in 2008, 56
2-2 Processing steps for converting corn grain to ethanol, 56
2-3 U.S. corn production and use as fuel ethanol from 1980 to 2009, 59
2-4 Installed capacity of all ethanol biorefineries in the United States from January 2002 to January 2010, 60
2-5 Location of ethanol biorefineries in the United States as of September 2010, 60
2-6 Distribution of planted soybean acres in the United States in 2008, 61
2-7 Process flow of biodiesel production, 62
2-8 Biodiesel refineries in the United States (2008), 64
2-9 Long-term (30-year average) switchgrass yield in the United States as simulated by the Environmental Policy Integrated Climate (EPIC) model, 69
2-10 Map of potential switchgrass yield in low-land ecotype predicted by Jager et al.'s empirical model, 70
2-11 Projected annual average harvestable yield of M. × giganteus in the third year after planting, 72
2-12 Net primary forest productivity in the conterminous United States, 78
2-13 Forest land in the conterminous United States by ownership category, 78
2-14 Model of a lignocellulosic based ethanol biochemical refinery, 82
2-15 Thermochemical conversion pathways and products, 83
2-16 Schematic diagram of a thermochemical conversion refinery to produce ethanol, 84
2-17 Percent companies with secured funding for demonstration of nonfood-based biofuel refineries that plan to produce drop-in fuels, ethanol, and oil feedstock, 88
2-18 Percent companies with secured funding for demonstration of nonfood-based biofuel refineries that plan to produce algal biofuels or cellulosic biofuels via biochemical or thermochemical pathways, 88

3-1 Biomass supply curves estimated by the National Biorefinery Siting Model, 115
3-2 Biofuel supply and fuel pathways estimated from the National Biorefinery Siting Model, 116
3-3 Principle amounts and locations of landscape derived biomass feedstocks for biofuels from the NBSM
A. Agricultural residue availability (dry tons per county)
B. Energy crop yields (Mg per hectare) and projections of maximum available supplies (maximum dry tons)
C. Estimated forest residue on public and private land (dry tons per county), 117
3-4 Biomass deliveries to the biorefineries needed to meet the RFS2 in 2022 projected by NBSM, 119
3-5 Locations of cellulosic facilities projected by the EPA Transport Tool, 121
3-6 Projected locations and quantities of cropland and forest resources for producing 20 billion gallons of cellulosic biofuels based on REAP and POLYSYS, 124
3-7 Locations of advanced biofuel projects including pilot-scale, demonstration-scale, and commercial-scale projects funded by DOE (red dots) and proposed by industry (blue dots), 127

4-1 Biomass supplier WTA per dry ton projected by BioBreak model, 146
4-2 Gap between supplier WTA and processor WTP projected by BioBreak model, 148
4-3 Components of trees and their use and value in markets, 149
4-4 Sensitivity of WTP for switchgrass (SC) to the price of oil and ethanol conversion rate without policy incentives, 150
4-5 Gap between supplier WTA and processor WTP with blender's credit only projected by BioBreak model, 151
4-6 Breakdown of biomass conversion costs, 156
4-7 Allocation and use of U.S. cropland from 1965 to 2006, 158
4-8 Harvested acres of corn, soybean (all), wheat, and hay (all from 1965 to 2009), 158
4-9 Real prices for corn, soybeans, and wheat from 1965 to 2010 crop year, 159
4-10 U.S. corn-grain production from 1965 to 2010 crop year, 160
4-11 U.S. soybean and wheat (all) production from 1965 to 2010 crop year, 160
4-12 U.S. domestic consumption of corn, soybean, and wheat from 1965-2010 crop year, 161
4-13 U.S. net exports of corn, soybean, and wheat from 1965 to 2009, 162
4-14 Annual yields for corn grain, soybean, and wheat from 1965 to 2010, 162
4-15 Trends in real international prices of key cereals: 1960 to May 2008, 163
4-16 Historical U.S. timber stumpage prices for the Pacific Northwest west-side of the Cascades softwood sawtimber (PNWW), Southern softwood sawtimber, and Southern softwood pulpwood, 173
4-17 Wood used in energy, 174
4-18 Effect of subsidy (panel A) and increase in demand (panel B) on extraction of residues from the forest floor for biomass energy markets, 175
4-19 Industrial wood output in the United States, 179
4-20 Net imports of wood into the United States (Imports - exports), 180
4-21 Price and quantity of biofuel demanded and supplied with and without RFS2 mandate and tax credit, 185
4-22 Effect of the Volumetric Ethanol Excise Tax Credit on price and quantity of ethanol, 186

4-23 Projected carbon price needed for feedstock market ($ per metric ton) based on BioBreak and using GREET 1.8d GHG emissions savings from biofuel relative to conventional gasoline along with the price gap to derive a minimum carbon credit or carbon price necessary to sustain a feedstock-specific cellulosic ethanol market, 207
4-24 Typical carbon accumulation on mixed hardwood stands in the Eastern Corn Belt of the United States, 209
4-25 Growth of growing stock biomass, 212

5-1 Historical trend in corn-grain ethanol biorefinery energy use, 241
5-2 Contribution of different emission categories to life-cycle emissions of corn-grain ethanol production as measured in an attributional GHG accounting of a Midwestern U.S. facility, 241
5-3 Probability distributions for U.S. industry GHG emissions for corn and switchgrass (SW) biofuels, 242
5-4 Life-cycle emissions of VOC, SO_x, NO_x, NH_3, and primary $PM_{2.5}$ from gasoline, dry-mill corn-grain ethanol produced using natural gas at the biorefinery, cellulosic ethanol from corn stover, and cellulosic ethanol from switchgrass, 248
5-5 Human health damage costs (dollars per gallon of gasoline equivalent) of life-cycle air quality impacts of gasoline, corn-grain ethanol, and cellulosic ethanol, 249
5-6 Model estimates of nitrogen and phosphorus yield from runoff in the Mississippi River Basin for 1992-2002, 254
5-7 Groundwater drawdown in the surficial aquifer (High Plains Aquifer) in Nebraska as a result of years of agricultural and municipal withdrawals, 236
5-8 U.S. irrigation corn for grain, 264
5-9 Total water withdrawals (from agriculture, municipalities, and industry) in the United States by county in 2000, 265
5-10 Ethanol biorefineries superimposed on a map of the major bedrock aquifers and their water usage rates, 268
5-11 Conceptual framework for comparing trade-offs of ecosystem services under different land uses, 279
5-12 Average 2004-2006 saturated thickness for the High Plains Aquifer in Kansas, 284
5-13 Usable lifetime of the High Plains Aquifer in Kansas estimated on the basis of groundwater trends from 1996-2006 and the minimum saturated requirements to support well yields of 400 gallons per minute under a scenario of 90 days of pumping with wells on ¼ sections, 285

BOXES

S-1 Definitions of Renewable Fuels in RFS2, 24

1-1 Structure of the Report, 36

4-1 Calculating WTP, 139
4-2 Calculating WTA, 141
4-3 Gap in Forest Residue Demand and Supply, 149
4-4 Biomass Crop Assistance Program, 177
4-5 State and Federal Subsidy Expenditures on Energy in Texas, 189
4-6 Comparison of Southern Pine and Hybrid Poplar in Producing Timber and Biomass on Similar Sites, 211

5-1 Illustration of How Different Approaches of Life-Cycle Assessment are Used for Different Purposes, 226
5-2 Methodological Assumptions Affecting GHG LCA Analyses, 239
5-3 Sustainability Concerns Associated With Using Forest Resources to Meet RFS2, 290

Summary

Biofuels that can be produced from renewable domestic resources offer an alternative to petroleum-based fuels. To encourage the production and consumption of biofuels in the United States, the U.S. Congress enacted the Renewable Fuels Standard (RFS) as part of the 2005 Energy Policy Act and amended it in the 2007 Energy Independence and Security Act (EISA). The RFS, as amended by EISA (referred to as RFS2 hereafter), mandated volumes of renewable fuels to be used in U.S. transportation fuel from 2008 to 2022 (Figure S-1; see Box S-1 for definitions of renewable fuels pertaining to RFS2). At the request of the U.S. Congress, the National Research Council convened a committee of 16 experts to provide an independent assessment of the economic and environmental benefits and concerns associated with achieving RFS2. The committee drew on its own expertise and solicited input from many experts in federal agencies, academia, trade associations, stakeholders' groups, and nongovernmental organizations in a series of open meetings and in writing to fulfill the statement of task. (See complete statement of task in Appendix A.)

The committee was asked to:

- Describe biofuels produced in 2010 and projected to be produced and consumed by 2022 using RFS-compliant feedstocks primarily from U.S. forests and farmland. The 2022 projections were to include per-unit cost of production.
- Review model projections and other estimates of the relative effects of increasing biofuels production as a result of RFS2 on the prices of land, food and feed, and forest products; on the imports and exports of relevant commodities; and on federal revenue and spending.
- Discuss the potential environmental harm and benefits of biofuels production and the barriers to achieving the RFS2 consumption mandate.

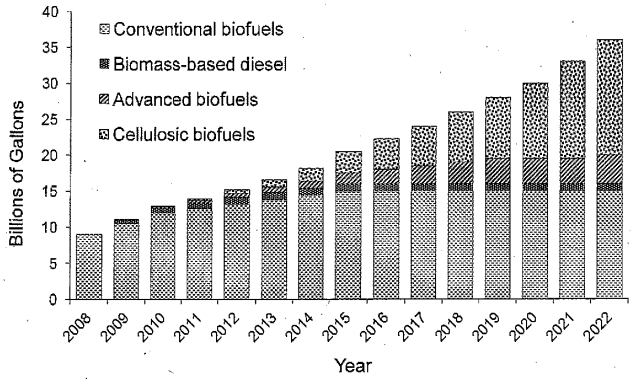


FIGURE S-1 Renewable fuel volume consumption mandated by RFS2.
NOTE: All volumes, except for volumes of biomass-based diesel, are shown in billions of gallons of ethanol-equivalent. The consumption mandate for biomass-based diesel is to be met on a biodiesel-equivalent basis.

BOX S-1

Definitions of Renewable Fuels in RFS2

RFS2 divides the total renewable fuel requirement into four categories:

- Conventional biofuel that is ethanol derived from corn starch and has a life-cycle greenhouse gas (GHG) threshold of at least 20-percent reduction in emissions compared to petroleum-based gasoline and diesel.
- Biomass-based diesel that achieves life-cycle GHG threshold of at least 50 percent.
- Advanced biofuels that are renewable fuels other than ethanol derived from corn starch and that achieve a life-cycle GHG threshold of at least 50 percent. Advanced biofuels can include cellulosic biofuels and biomass-based diesel.
- Cellulosic biofuels derived from any cellulose, hemicellulose, or lignin from renewable biomass that achieve a life-cycle GHG threshold of at least 60 percent.

KEY FINDINGS

FINDING: Absent major technological innovation or policy changes, the RFS2-mandated consumption of 16 billion gallons of ethanol-equivalent cellulosic biofuels is unlikely to be met in 2022.

The United States had the capacity to produce 14.1 billion gallons of ethanol per year from corn grain and 2.7 billion gallons of biodiesel per year from soybean oil, other vegetable oils, and animal fats at the end of 2010. That year, about 13.2 billion gallons of ethanol and 311 million gallons of biodiesel were produced in the United States. Therefore, adequate volumes are likely to be produced to meet the consumption mandates of 15 billion gallons of conventional biofuel and at least 1 billion gallons of biodiesel[1] by 2022. In contrast, whether and how the mandate for cellulosic biofuels will be met is uncertain. Although several studies suggested that the United States can produce adequate biomass feedstock for conversion to 16 billion gallons of ethanol-equivalent cellulosic biofuels to meet the consumption mandate, no commercially viable biorefineries exist for converting lignocellulosic biomass to fuels as of the writing of this report. Another report, *Liquid Transportation Fuels from Coal and Biomass: Technological Status, Costs, and Environmental Impacts*, estimated that aggressive deployment, in which the capacity build rate doubles the historic capacity build rate of corn-grain ethanol, is needed if 16 billion gallons of ethanol-equivalent cellulosic biofuels are to be produced by 2022. That estimate was based on the assumption that robust commercial-scale technology would be ready for deployment by 2015. Although the government guarantees a market for cellulosic biofuels regardless of price up to the level of the consumption mandate,[2] policy uncertainty and high cost of production might deter investors from aggressive deployment. Therefore, the capacity for producing cellulosic biofuels to meet the RFS2 consumption mandate will not be available unless innovative technologies are developed that unexpectedly improve the cellulosic biofuels production process and technologies are scaled up and undergo several commercial-scale demonstrations in the next few years to optimize capital and operating costs.

FINDING: Only in an economic environment characterized by high oil prices, technological breakthroughs, and a high implicit or actual carbon price would biofuels be cost-competitive with petroleum-based fuels.

The committee used the Biofuel Breakeven Model to evaluate the costs and feasibility of a local or regional cellulosic biomass market for a variety of potential feedstocks. The model was used to estimate the minimum price that biomass producers would be willing to accept (WTA) for a dry ton of biomass delivered to the biorefinery gate and the maximum price that biorefineries would be willing to pay (WTP) to at least break even.

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[1]The actual consumption mandate for biomass-based diesel is 1.0 billion gallons per year in 2012. Thereafter, the volume, no less than 1.0 billion gallons of biodiesel equivalent per year, is to be determined by EPA in a future rule making.

[2]RFS2 mandates that the production capacity of cellulosic biofuels be used to the extent that companies build it.

The price of crude oil, which is the chief competitor with biofuels, is a key determinant in the competitiveness of cellulosic biofuel and other advanced biofuels in the marketplace. Because crude oil prices are highly volatile, the difference between the WTP and WTA was calculated for three oil prices: $52, $111, and $191 per barrel, which are the low, reference, and high price projections for 2022 from the Department of Energy's Annual Energy Outlook in 2008$. Table S-1 shows that the price gap is positive for all potential cellulosic feedstocks if the oil price is $111 per barrel and policy incentives for biofuels do not exist. In this scenario, no cellulosic feedstock market is feasible without policy incentives.

TABLE S-1 Estimated Unit Price that Biorefineries are Willing to Pay (WTP) for Biofuel Feedstock and Estimated Unit Price that Suppliers are Willing to Accept (WTA) for Cellulosic Biomass when Oil is $111 per Barrel and No Policy Incentives Exist

	WTA	WTP	Price Gap (Per Dry Ton)	Price Gap (Gallon of Ethanol)
Corn Stover in a Corn-Soybean Rotation	$92	$25	$67	$0.96
Corn Stover in a 4-year Corn-Alfalfa Rotation	$92	$26	$66	$0.94
Alfalfa	$118	$26	$92	$1.31
Switchgrass in the Midwest	$133	$26	$106	$1.51
Switchgrass in Appalachia	$100	$26	$74	$1.06
Miscanthus in the Midwest	$115	$26	$89	$1.27
Miscanthus in Appalachia	$105	$27	$79	$1.13
Wheat Straw	$75	$27	$49	$0.70
Short-Rotation Woody Crops	$89	$24	$65	$0.93
Forest Residues	$78	$24	$54	$0.77

NOTE: Conversion yield of biomass to ethanol is assumed to be 70 gallons per dry ton. These results are based on original modeling work by the committee that builds upon the work performed in *Liquid Transportation Fuels from Coal and Biomass: Technological Status, Costs, and Environmental Impacts* (NAS-NAE-NRC, 2009).

A cellulosic feedstock market would be feasible under other circumstances, such as if the price of oil reaches $191 per barrel, if a carbon price makes the price of cellulosic biofuels more competitive, if government subsidy payments are high enough, or if government mandates are enforced at given levels of biofuel blending. Oil price affects both the processor's WTP through fuel revenues and the supplier's WTA through production, handling, and transport costs. The price gap is eliminated for several feedstocks when oil prices are at or above $191 per barrel. Alternatively, a carbon price[3] of $118-$138 per tonne of CO_2 equivalent can close the gap between WTP and WTA at an oil price of $111 per barrel for some feedstocks given current technology. A subsidy of $1.01 per gallon of cellulosic biofuel blended with fossil fuel was

[3]A carbon price can be enacted through a carbon tax credit provided to the biofuel producer (or feedstock supplier) per dry ton of cellulosic feedstock refined or as the market price for carbon credits if processors are allocated marketable carbon credits for biofuel GHG reductions relative to conventional gasoline.

established in 2008, but this payment is not sufficient to close the price gap at $111 per barrel of oil.[4]

RFS2 is decoupled from biofuel cost of production and economics. Although the economics may be a strong deterrent to developing capacity, cellulosic biofuels will have a government-mandated market to the extent that capacity is built. The future of RFS2 after it expires in 2022 is a source of uncertainty for investors.

FINDING: RFS2 may be an ineffective policy for reducing global GHG emissions because the effect of biofuels on GHG emissions depends on how the biofuels are produced and what land-use or land-cover changes occur in the process.

GHGs are emitted into the atmosphere or stored in soil during different stages of biofuel production—for example, CO_2 storage in biomass during growth and emissions from fossil fuel combustion in the manufacturing, transport, and application of agricultural inputs, from fermentation to ethanol, and from tailpipe emissions. Processes that affect GHG emissions of biofuels also include land-use and land-cover changes. If the expanded production involves removing perennial vegetation on a piece of land and replacing it with an annual commodity crop, then the land-use change would incur a one-time GHG emission from biomass and soil that could be large enough to offset GHG benefits gained by displacing petroleum-based fuels with biofuels over subsequent years. Furthermore, such land conversion may disrupt any future potential for storing carbon in biomass and soil. In contrast, planting perennial bioenergy crops in place of annual crops could potentially enhance carbon storage in that site.

Indirect land-use change occurs if land used for production of biofuel feedstocks causes new land-use changes elsewhere through market-mediated effects. The production of biofuel feedstocks can constrain the supply of commodity crops and raise prices. If agricultural growers anywhere in the world respond to the market signals (higher commodity prices) by expanding production of the displaced commodity crop, indirect land-use change occurs. This process might ultimately lead to conversion of noncropland (such as forests or grassland) to cropland. Because agricultural markets are intertwined globally, production of bioenergy feedstock in the United States will result in land-use and land-cover changes somewhere in the world, but the extent of those changes and their net effects on GHG emissions are uncertain.

Biofuels produced from residues or waste products, such as corn stover and municipal solid waste, will not contribute much GHG emissions from land-use or land-cover changes as long as adequate residue is left in the field to maintain soil carbon. However, it is not economically and environmentally feasible to produce enough biomass to meet RFS2 through crop residue or municipal solid waste. Therefore, dedicated energy crops will have to be grown to meet the mandate, which will likely require conversion of uncultivated cropland or the displacement of commodity crops and pastures. The extent of market-mediated land-use change and the associated GHG emissions as a result of increasing biofuels and dedicated bioenergy crop production in the United States are difficult to estimate and highly uncertain. Although RFS2 imposes restrictions to discourage bioenergy feedstock producers from land-clearing or land-cover change in the United States that would result in net GHG emissions, the policy cannot

[4]These conclusions are based on average prices for a cellulosic biofuels industry that is assumed to be commercially competitive and viable. Other studies have shown small quantities of biomass feedstocks could be available at significantly lower prices.

prevent market-mediated effects nor control land-use or land-cover changes in other countries. Therefore, the extent to which biofuel produced from dedicated energy crops will result in savings in GHG emissions compared to using petroleum is uncertain.

ECONOMIC EFFECTS OF INCREASING BIOFUELS PRODUCTION

Land Prices

FINDING: Absent major increases in agricultural yields and improvement in the efficiency of converting biomass to fuels, additional cropland will be required for cellulosic feedstock production; thus, implementation of RFS2 is expected to create competition among different land uses, raise cropland prices, and increase the cost of food and feed production.

Cropland acreage in the United States has been declining as it has in all developed countries. If the United States produces 16 billion gallons of ethanol-equivalent cellulosic biofuels by 2022, 30-60 million acres of land might be required for cellulosic biomass feedstock production, thereby creating competition among land uses. Although biofuels produced from crop and forest residues and from municipal solid wastes could reduce the amount of land needed for cellulosic feedstock production, those sources are inadequate to supply 16 billion gallons of ethanol-equivalent cellulosic biofuels, particularly if a proportion of crop and forest residues are left in the field to maintain soil quality.

Food and Feed Prices

FINDING: Food-based biofuel is one of many factors that contributed to upward price pressure on agricultural commodities, food, and livestock feed since 2007; other factors affecting those prices included growing population overseas, crop failures in other countries, high oil prices, decline in the value of the U.S. dollar, and speculative activity in the marketplace.

To date, the agricultural commodities most affected by U.S. biofuels production are corn and soybean. The increased competition for these commodities created by an expanding biofuels market has contributed to upward pressure on their prices, but the increase has had a small effect on consumers' food retail prices, except livestock products, because corn and soybean typically undergo some processing before reaching consumers' food basket. The difference between the price of an unprocessed commodity and the retail price of processed food is typically large. The committee estimated that an increase of 20-40 percent in agricultural commodity prices would result in an increase in the retail price of most processed grocery food products (for example, breakfast cereal and bread) containing those commodities of only 1 to 2 percent.

Corn and soybean are used as animal feed, so the livestock market has experienced increased competition from the biofuels market. Some of this competition is alleviated by the ability of livestock producers to feed their animals dried distillers' grain with solubles (DDGS), a

coproduct of dry-milling corn-grain into ethanol. However, there are limits to the amount of DDGS that can be used without impairing efficient production and the quality of the product. Moreover, increased commodity prices raise the production costs of livestock, and the animal producer's ability to pass increased production costs quickly on to consumers is limited because high prices decrease demand. The reproductive pipeline involved in livestock production makes it difficult for producers to adjust herd numbers quickly in response to increased feed costs.

Price of Woody Biomass

Wood is the most widely available cellulosic bioenergy feedstock in the United States at present, and it will be an important source of supply for cellulosic biofuel refineries if they become economically viable. If a commercial woody biomass refinery is built, it would require a large supply of dry biomass to operate efficiently (1,000-2,000 dry tons per day). Residues from forest harvesting operations could provide only a modest supply of cellulosic feedstock for such an operation due to the high marginal cost of harvesting these additional materials, the limited legal definition for accessing residues, and the uncertain nature of future federal subsidies. Although there are currently large supplies of milling residues in the wood processing industry, most of these residues are already committed to electricity production (in recent years, up to 132 million dry tons of roundwood equivalent[5]), and thus would be costly for cellulosic biofuel producers to purchase. Pulpwood is the closest marketable commodity that could enter woody biomass markets, but it is a higher value product (and thus more costly as a feedstock) than either forest harvest residues or milling residues. As a result, RFS2 is likely to have large effects on wood product prices. Some factors could mitigate these effects, including technological breakthroughs that reduce the cost of extracting forest residues, changes in the legal definition for accessing residues, and the size of subsidies for forest residues.

Imports and Exports of Relevant Commodities

A growing biofuel industry was one factor that contributed to an increase in international commodity prices. However, exports of corn, soybean, and wheat held steady or even increased largely due to a huge decline in the value of the U.S. dollar between 2002 and 2008. With a lower value for the U.S. dollar, commodity prices did not increase nearly as much in other currencies such as the euro or yen. If commodity prices had not increased as a result of biofuels production and other factors and the U.S. dollar had still depreciated, exports likely would have increased more.

Increased animal product costs (for example, prices of meat and dairy) as a result of the simultaneous implementation of RFS2 and the European Union's biofuel mandates are expected to decrease the global value of livestock industries substantially, with one estimate being $3.7 billion between 2006 and 2015 (2006$). Most of this decrease will occur outside the United States, which will observe only a minor reduction ($0.9 billion) in its livestock and processed livestock products. The effect in the United States is buffered by the increasing availability of coproducts from corn-grain ethanol production, especially DDGS.

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[5]This includes industrial roundwood used directly to produce energy as well as residues, black liquor from the pulping process, and fuelwood harvested from the forest.

Current estimates suggest that the RFS2 mandate will likely increase wood imports into the United States. If wood currently used by the wood processing sector is diverted to meeting the RFS2 mandate, the shift in industrial wood from traditional uses to biofuels could cause the United States to import more industrial wood from elsewhere. The scale of this effect, however, cannot be precisely estimated at this time.

Achieving RFS2, along with increasing fuel efficiency standards in vehicles, can contribute to reducing the nation's dependence on oil imports. If RFS2 is to be achieved, domestically produced biofuels can displace 1.6 million barrels of petroleum-based fuels each day. (Consumption of petroleum-based transportation fuels in 2009 was 13 million barrels per day.) Even if part of the RFS2 consumption is to be met by imported ethanol, a net reduction in the volume of imported oil is expected.

Federal Budget

FINDING: Achieving RFS2 would increase the federal budget outlays mostly as a result of increased spending on payments, grants, loans, and loan guarantees to support the development of cellulosic biofuels and forgone revenue as a result of biofuel tax credits.

Federal Spending

Agricultural Commodity Payments

Federal spending on agricultural commodity payments is not expected to change as a result of increasing biofuel production in the United States. Government payments to the producers of the major agricultural commodities primarily take one of two forms: direct payments and countercyclical payments. Direct payments are fixed payments provided to crop producers regardless of the market price received by crop producers. Thus, under no circumstances would RFS2 generate savings in the budget cost of the direct payment program. Countercyclical payments are paid when the market price for a crop is less than the effective target price of that crop. The effective target price of a crop is calculated as the legislated target price of that crop minus the direct payment for that crop. U.S. agricultural commodity prices are projected to exceed effective target prices from 2011 to 2021. If these projections hold true, then no countercyclical payments will be paid.

Conservation Reserve Program

The effect of biofuel production on the federal spending for conservation programs is uncertain. The Conservation Reserve Program (CRP) is the largest federal conservation program directed at agricultural land. Its objective is to provide "technical and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner" (http://www.nrcs.usda.gov/programs/crp/). At the time this report was written, participants in the program received an average payment of $44 an acre. Federal outlays for fiscal year 2010 were

estimated to cost $1.7 billion. If land is withdrawn from CRP for biofuel feedstock production and not replaced by new enrollment, the cost of CRP will decrease. However, CRP application acreage in a given year typically exceeds the maximum program acreage. The cost of the program will increase if enrollment applications are insufficient and if per-acre payment levels are increased to keep CRP competitive with crop or biofuel feedstock production and to incentivize producers to keep the most sensitive land in the program.

Nutritional and Other Income Assistance Program

Nutritional and other income assistance programs are often adjusted for changes in the general price level as a means of protecting the real purchasing power of program recipients; therefore, if food retail prices increase, the program payments will typically be adjusted to reflect this change. Under such circumstances, expenses will increase not only for the Supplemental Nutrition Assistance Program and the Special Supplemental Assistance Program for Women, Infants, and Children,[6] but also for much larger income assistance programs, such as Social Security, military or civilian retirement programs, or Supplemental Security Income. Given that biofuels are only one of many factors affecting food retail prices, possible increases in the costs of these programs cannot be solely attributed to RFS2.

Grants, Loans, and Loan Guarantees

Grants, loans, and loan guarantees to support the production of feedstock, the cost of biofuel processing, and the development of cellulosic biofuel infrastructure have also been made. Biofuel production subsidies that reduce the cost of feedstock purchased by cellulosic biofuel refineries are typically provided in the form of payments per unit of feedstock purchased. Research into lowering the cost of biofuel processing can be aimed at many different areas in the production chain, including investment in increasing crop yields and in increasing the amount of biofuel produced per unit of biomass. Subsidies to reduce the capital investment cost of constructing cellulosic biofuel refineries are typically provided in the form of tax credits, grants, loans, or loan guarantees that provide a rate of interest below that which investors could obtain from alternative financing sources.

Forgone Federal Revenue

Transportation fuels are taxed in the United States, but the structure of excise tax rates and exemptions varies by transportation mode and fuel type. Biofuel use is encouraged through a federal tax credit to fuel blenders. The 2008 farm bill set the Volumetric Ethanol Excise Tax Credit (VEETC) at $0.45 per gallon of ethanol blended with gasoline. Blenders receive a $1 per gallon tax credit for the use of biodiesel, and a $1.01 per gallon credit for the use of cellulosic biofuel. The value of payments made to blenders for the use of biodiesel and cellulosic biofuel is less than $1 billion a year because these fuels are not produced in large volumes. However, forgone federal tax revenue as a result of VEETC was $5.4 billion in 2010 and is anticipated to increase to $6.75 billion in 2015 as corn-grain ethanol production approaches the mandate limit.

[6]Two nutritional assistance programs operated by the U.S. Department of Agriculture.

The forgone revenue is much larger than any savings that could be gained from reduced CRP enrollment. As of writing of this report, the biofuel subsidies were under review by Congress.

Impact with No Federal Subsidies

All biofuel tax credits will end in 2012 unless Congress takes action to extend them, but RFS2 will remain in effect. Without biofuel tax credits and with RFS2 in effect, the cost of biofuel programs is borne directly by consumers, as they are forced to pay a higher cost for the blended renewable fuel than for petroleum-based products. Otherwise, consumers bear the cost of biofuel programs indirectly through taxes paid.

ENVIRONMENTAL EFFECTS OF INCREASING BIOFUELS PRODUCTION

FINDING: The environmental effects of increasing biofuels production largely depend on feedstock type, site-specific factors (such as soil and climate), management practices used in feedstock production, land condition prior to feedstock production, and conversion yield. Some effects are local and others are regional or global. A systems approach that considers various environmental effects simultaneously and across spatial and temporal scales is necessary to provide an assessment of the overall environmental outcome of increasing biofuels production.

Although using biofuels holds potential to provide net environmental benefits compared to using petroleum-based fuels, the environmental outcome of biofuels production cannot be guaranteed because the key factors that influence environmental effects from bioenergy feedstock production are site specific and depend on the type of feedstocks produced, the management practices used to produce them, prior land use, and any land-use changes that their production might incur. In addition to GHG emissions, biofuel production affects air quality, water quality, water quantity and consumptive use, soil, and biodiversity. Thus, the environmental effects of biofuels cannot be focused on one environmental variable. Environmental effects of increasing biofuels production have to be considered across spatial scales because some effects are local and regional (for example, water quality and quantity) and others are global (for example, GHG emissions have the same global effect irrespective of where they are emitted). Planning based on landscape analysis could help integrate biofuel feedstock production into agricultural landscapes in ways that improve environmental outcomes and benefit wildlife by encouraging placement of cellulosic feedstock production in areas that can enhance soil quality or help reduce agricultural nutrient runoffs, anticipating and reducing the potential of groundwater overuse and enhancing wildlife habitats.

Air Quality

Air quality modeling suggests that production and use of ethanol as fuel to displace gasoline is likely to increase such air pollutants as particulate matter, ozone, and sulfur oxides. Published studies projected that overall production and use of ethanol will result in higher pollutant concentration for ozone and particulate matter than their gasoline counterparts on a

national average. Unlike GHG effects, air quality effects from corn-grain ethanol are largely localized. The potential extent to which the air pollutants harm human health depends on whether the pollutants are emitted close to highly populated areas and exposure.

Water Quality

An assessment of the effects of producing biofuels to achieve the RFS2 consumption mandate on water quality requires detailed information on where the bioenergy feedstocks would be grown and how they would be integrated into the existing landscape. The increase in corn production has contributed to environmental effects on surface and ground water, including hypoxia, harmful algal blooms, and eutrophication. Additional increases in corn production under RFS2 likely will have additional negative environmental effects (though production of corn-grain ethanol in 2010 was only 1 billion gallons less than the consumption mandate for years 2015 to 2022). Perennial and short-rotation woody crops for cellulosic feedstocks with low agrichemical inputs and high nutrient uptake efficiency hold promise for improving water quality under RFS2, particularly if integrated with food-based crops. Use of residues would not require much additional inputs so that they are not likely to incur much negative effects on water quality as long as enough residues are left in field to prevent soil erosion. The site-specific details of the implementation of RFS2, and particularly the balance of feedstocks and levels of inputs, will determine whether or not RFS2 will lead to improved or diminished water quality.

Water Quantity and Consumptive Water Use

Published estimates of consumptive water use over the life cycle of corn-grain ethanol (15-1,500 gallons per gallon of gasoline equivalent) and cellulosic biofuels (2.9-1,300 gallons per gallon of gasoline equivalent) are higher than petroleum-based fuels (1.9-6.6 gallons per gallon of gasoline equivalent), but the effects of water use depend on regional availability. An individual refinery might not pose much stress on a water resource, but multiple refineries could alter the hydrology in a region. In particular, biorefineries are most likely situated close to sources of bioenergy feedstock production, both of which draw upon local water resources. Yet, regional water availability was not always taken into account in the models that project cellulosic biorefinery locations.

Soil Quality and Biodiversity

Effects of biofuels production on soil quality and biodiversity primarily result from the feedstock production and removal stages, particularly on the rates of biological inputs and outputs and the levels of removal. The effects of achieving RFS2 on biodiversity currently cannot be readily quantified or qualified largely because of the uncertainty in the future. Bioenergy feedstock production can reduce or enhance biodiversity depending on the compatibility of feedstock type, management practices, timing of harvest, and input use with plants and animals in the area of production and its surroundings. Precise regional assessments at each site of feedstock production for biofuels are needed to assess the collective effects of achieving RFS2 on biodiversity.

BARRIERS TO ACHIEVING RFS2

FINDING: Key barriers to achieving RFS2 are the high cost of producing cellulosic biofuels compared to petroleum-based fuels and uncertainties in future biofuel markets.

RFS2 guarantees a market for cellulosic biofuels produced, but market uncertainties could deter private investment. Of the three crude oil prices tested in this study, the only one for which biofuels were economic without subsidies was $191. The breakeven crude oil price would be between $111 and $191. If the biofuel is ethanol, there also are infrastructure and blend wall[7] issues to surmount. Production of "drop-in"[8] fuels instead of ethanol would eliminate these additional downstream costs. Although RFS2 provides a market for the biofuels produced even at costs considerably higher than fossil fuels, uncertainties in enforcement and implementation of RFS2 mandate levels affect investors' confidence and discourage investment. EPA has the right to waive or defer enforcement of RFS2 under a variety of circumstances, and the agency is "required to set the cellulosic biofuel standard each year based on the volume projected to be available during the following year." In 2011, the RFS level of 250 million gallons of ethanol-equivalent cellulosic biofuel was reduced to 6.6 million gallons. As of 2011, biofuel production is contingent on subsidies, RFS2, and similar policies.

Opportunities to reduce costs of biofuels include decreasing the cost of bioenergy feedstock, which constitutes a large portion of operating costs, and increasing the conversion efficiency from biomass to fuels. Research and development to improve feedstock yield through breeding and biotechnology and conversion yield could reduce costs of biofuels production and potentially reduce the environmental effects per unit of biofuel produced.

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[7]Most ethanol in the United States is consumed as a blend of 10-percent ethanol and 90-percent gasoline. If every drop of gasoline-type fuel consumed in the U.S. transportation could be blended, then a maximum of about 14 billion gallons of ethanol could be blended.

[8]A non-petroleum fuel that is compatible with existing pipelines and delivery mechanisms for petroleum-based fuels.

LETTER FROM CHAIRMAN RALPH M. HALL TO HONORABLE LISA JACKSON, ADMINISTRATOR, ENVIRONMENTAL PROTECTION AGENCY

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July 25, 2011

The Honorable Lisa Jackson
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460

Dear Administrator Jackson:

I am writing concerning the Environmental Protection Agency's (EPA) decision to proceed with developing a "Tier 3" rulemaking that would establish more stringent fuel specifications and light-duty vehicle emissions standards. It is my understanding that EPA expects to issue a proposed rule by the end of 2011 and a final rule in 2012.

These regulations will have significant economic implications. Compliance with these new standards will require refineries to make very large capital investments in an effort to reduce sulfur and vapor pressure in gasoline. When coupled with other EPA regulations on our Nation's refineries, such as greenhouse gas (GHG) regulations and an increasingly stringent National Ambient Air Quality (NAAQS) standard for ozone, domestic refineries could be placed at a competitive disadvantage that may result in refinery closures. Refinery closures could mean less domestic supply of gasoline, increased imports, reduced energy security and the loss of good paying domestic jobs at a time when our Nation can least afford additional unemployment.

Even faced with all of these potential economic repercussions on consumers and the domestic refining industry, EPA is proceeding without having made a determination that the health and welfare of the public will benefit from this rulemaking and without having completed a Congressionally-mandated study. Section 209 of the Energy Independence and Security Act (EISA) of 2007 required EPA to complete a study, 18 months after the date of enactment, to determine whether the "renewable fuel volumes required by this section (Section 211) will adversely impact air quality" and to make a determination as to whether additional fuel requirements are necessary before proceeding with a rulemaking.

During a July 7th hearing held by the Energy and Environment Subcommittee of this Committee, EPA Director of the Office of Transportation and Air Quality (OTAG) Ms. Margo Oge confirmed to me that EPA failed to complete the Section 209 antibacksliding study by the statutory deadline. According to Ms. Oge, the study remains uncompleted.

As the basis of any rulemaking should include an adequate body of sound scientific research and the opportunity for comment by all stakeholders in the process, EPA's decision to proceed, with this rulemaking, in the absence of key information is premature, irresponsible, and inconsistent with the law.

Given that EISA directed EPA to use the Section 209 study as a foundation for a rulemaking found to be necessary, before proceeding, EPA must complete the study mandated by section 209 and provide the essential data showing that lowering the sulfur content and vapor pressure of gasoline will achieve cost effective, real emissions reductions and associated benefits; and is necessary for meeting 2017 vehicle emissions standards.

I find the current situation troubling and ask that you provide responses to the following:

1) Please detail the reasons for the failure to complete the aforementioned anti-backsliding study mandated in Section 209 of EISA and due in June 2009.

2) Please provide a timeline for completion of the anti-backsliding study.

3) Please detail budgetary support for this study, both with respect to current FY 11 spending as well as that requested for FY 12.

4) Please describe the process that EPA plans to follow in making the anti-backsliding data and study available to the public for review and comments.
   a. When will EPA release the results of this assessment to the public?
   b. Please describe the timing and the process EPA plans to use in response to public comments on the study.
   c. How do these processes align with the transparency and openness principles outlined in your memo entitled "Transparency in EPA's Operations," dated April 23, 2009?

5) EPA was directed to use the anti-backsliding study as the basis for any necessary future changes to fuels. Given that the study has not been published, what authorization does EPA have to pursue fuel specification changes? What scientific and technical information is EPA relying on in the absence of the data the anti-backsliding study was to provide?

6) Please describe EPA's rationale and data in the development of new fuels rules.

7) Has EPA completed an assessment of the potential need for additional controls?

8) Is it the Agency's intent to use the new NAAQS for ozone as a basis for the determination that additional controls are needed? If so, please describe the timing of features of the yet to be established new NAAQS for ozone and how they tie to the 2017 Presidential target date for new GHG requirements and potential additional controls on vehicles and fuel quality.

9) Provide the detailed scientific and technical assessment EPA used to make a determination that health and welfare of the public will benefit from further sulfur reductions beyond current standards.

10) Has EPA identified, if any, emission control devices impaired by current sulfur standards? If so, please provide a detailed list of identified control devices.

11) Has EPA identified any new automotive technologies that can reasonably be expected to be deployed in the near term that would be impaired by current sulfur standards? If so, please provide a detailed list of the identified technologies.

12) Were the Tier 2 standards in place today for vehicles and gasoline quality established in conjunction with one another? Due to this process, was gasoline sulfur reduced for successful design and operation of Tier 2 vehicles? What conditions have changed that lead the Agency to believe that Tier 2 vehicles are no longer performing properly with Tier 2 fuels?

13) Has EPA calculated the up-front and recurring costs of such a regulation? Has EPA calculated how these costs would impact fuel prices?

14) What are the fuel supply impacts from reducing sulfur in gasoline? What are the fuel supply impacts from reducing vapor pressure?

15) Do other available markets exist for the light end products (e.g. butane & pentanes) that could no longer be used in gasoline blending due to the further reduction of sulfur?

More energy intensive refinery processes can increase refinery GHG emissions. Has EPA considered how Tier 3 regulation would impact refinery emissions?

a. Does EPA plan to credit refiners GHG requirements to offset new Tier 3 requirements?

b. If not, what impact will this regulation have on the competitiveness of U.S. refiners?

16) Is EPA taking U.S. energy security into consideration in developing a Tier 3 rule? Could this rule result in reduced supply, increased imports, refinery closures, or any combination thereof?

Please provide the written responses by no later than two weeks from the date of this letter. Should you have any questions please contact the Majority Energy and Environment Subcommittee Committee Staff at (202) 225-6371.

Sincerely,

Ralph M. Hall

Ralph Hall
Chairman

cc: The Honorable Eddie Bernice Johnson, Ranking Member
The Honorable Andy Harris, Chairman, Subcommittee on Energy and Environment
The Honorable Brad Miller, Ranking Member, Subcommittee on Energy and Environment

LETTER TO CHAIRMAN RALPH M. HALL FROM HONORABLE GINA MCCARTHY, ASSISTANT ADMINISTRATOR, ENVIRONMENTAL PROTECTION AGENCY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

SEP 12 2011

OFFICE OF
AIR AND RADIATION

The Honorable Ralph M. Hall
Chairman, Committee on Science, Space, and Technology
U.S. House of Representatives
Washington, D.C. 20515-6301

Dear Mr. Chairman:

Thank you for your letter of July 25, 2011, regarding the Environmental Protection Agency's "Tier 3" rulemaking that would establish new light-duty vehicle emissions standards and fuel standards and the "anti-backsliding study" required by the Energy Independence and Security Act (EISA).

First, let me assure you that the EPA is committed to developing a robust and transparent analysis to support consideration of Tier 3 vehicle and fuel standards. The Agency is in the process of conducting a thorough analysis of the emissions and air quality impacts of light-duty vehicles, and the environmental and health benefits of more protective vehicle and fuel standards. Establishing the baseline for this analysis requires an assessment of the air quality impacts of renewable fuels, which is also the subject of the anti-backsliding provisions. As a result, we are developing the anti-backsliding study required by Clean Air Act section 211(v) at the same time that we develop the comprehensive analysis related to Tier 3 vehicle and fuel standards.

Your letter posed 16 specific questions, and my responses are provided in the enclosure.

Again, thank you for your letter. If you have further questions, please contact me or your staff may call Diann Frantz in EPA's Office of Congressional and Intergovernmental Relations at (202) 564-3668.

Sincerely,

Gina McCarthy
Assistant Administrator

Enclosure

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Enclosure

1) *Please detail the reasons for the failure to complete the aforementioned anti-backsliding study mandated in Section 209 of EISA and due in June 2009.*

After EISA was enacted, the EPA's first priority was to draft regulations and implement the Renewable Fuel Standards mandated by the act. As part of that rulemaking effort, the EPA assessed the emission and air quality impacts of the standards. That regulatory analysis showed increases in air pollution resulting from the increased use of renewable fuels, but it was only for the incremental increase in renewable fuel volumes required by EISA, and was based on emissions data from older vehicles that were available at the time. Consequently, in parallel, the EPA undertook the long lead-time work needed for the anti-backsliding study, including extensive vehicle testing to quantify the impacts of fuel changes in modern vehicles and update the motor vehicle emissions model.

The EPA is currently conducting the anti-backsliding analysis, which is the culmination of years of vehicle testing, data analysis, and emissions modeling that the EPA has been conducting since the Energy Policy Act and EISA were enacted. The vehicle testing is now complete, the data are being analyzed, and the air quality modeling necessary for the anti-backsliding study is currently underway.

2) *Please provide a timeline for completion of the anti-backsliding study.*

The EPA is planning to release the draft study at the time of the Tier 3 proposal, which we expect in December 2011. We will finalize the study after a public comment period, and consideration of the public comments. This will satisfy the requirements of Clean Air Act section 211(q) for a draft report and public comment period, followed by a final report, as well as the requirements of section 211(v).

3) *Please detail budgetary support for this study, both with respect to current FY11 spending as well as that requested for FY 12.*

The EPA is spending approximately $250,000 in FY11 contract funds. FY12 funding has not yet been determined.

4) *Please describe the process that the EPA plans to follow in making the anti-backsliding data and study available to the public for review and comments.*

   a) When will the EPA release the results of this assessment to the public?

      The EPA is planning to release the draft study at the time of the Tier 3 proposal, which we expect in December 2011.

   b) Please describe the timing and the process the EPA plans to use in response to public comments on the study.

Following publication of a Federal Register notice, there will be a public comment period when written comments can be submitted.

c) How do these processes align with the transparency and openness principles outlined in your memo entitled "Transparency in the EPA's Operations," dated April 23, 2009?

This process is consistent with the "Transparency in the EPA's Operations" memo because we are providing opportunity for broad public participation. We will announce the study and the public comment period in the Federal Register, as well as on our web site, maximizing its visibility.

5) *The EPA was directed to use the anti-backsliding study as the basis for any necessary future changes to fuels. Given that the study has not been published, what authorization does the EPA have to pursue fuel specification changes? What scientific and technical information is the EPA relying on in the absence of the data the anti-backsliding study was to provide?*

The EPA is developing new Tier 3 standards for light-duty vehicles and their fuels using its general authority under Clean Air Act sections 202(a) and 211(c). This authority is separate from and not affected by the anti-backsliding requirements of section 211(v). The EPA is in the process of conducting a thorough analysis of the emissions and air quality impacts of light-duty vehicles, and the environmental and health benefits of more protective vehicle and fuel standards.

Establishing the baseline for this analysis requires an assessment of the air quality impacts of renewable fuels in the gasoline pool. As a result, it seems prudent to develop the draft anti-backsliding study at the same time that we develop the broader regulatory analysis supporting the Tier 3 proposal.

6) *Please describe the EPA's rationale and data in the development of the new rules.*

As noted above, the EPA is developing new "Tier 3" standards for light-duty vehicles and their fuels using its general authority under Clean Air Act sections 202(a) and 211(c) and is in the process of conducting a thorough analysis of the environmental and health benefits of more protective vehicle and fuel standards. The EPA's regulatory proposal will fully describe the rationale and data supporting any new rules as required by the Clean Air Act.

7) *Has the EPA completed an assessment of the potential need for additional controls?*

The thorough assessment of the need for Tier 3 standards is currently under development and will be contained in the regulatory proposal.

8) *Is it the Agency's intent to use the new NAAQS for ozone as a basis for the determination that additional controls are needed? If so, please describe the timing of features of the yet to be established new NAAQS for ozone and how they tie to the 2017 Presidential target date for new GHG requirements and potential additional controls on vehicles and fuel quality.*

No, the 2008 ozone NAAQS (as well as other NAAQS, such as particulate matter) provide a basis for the determination that additional controls are needed. The Regulatory Impact Analysis for the 2008 ozone NAAQS found that Tier 3 vehicle controls, as well as other controls, would be necessary to attain the standard. State air agencies are urging the EPA to adopt federal measures such as Tier 3 in order for them to attain the NAAQS.

9) *Provide the detailed scientific and technical assessment the EPA used to make a determination that health and welfare of the public will benefit from further sulfur reductions beyond the current standards.*

This assessment is being developed as part of the Tier 3 proposal and will be released as part of that rulemaking.

10) *Has the EPA identified any emission control devices impaired by current sulfur standards? If so, please provide a detailed list of identified control devices.*

Virtually every vehicle on the road today contains one or more precious metal catalysts to control emissions. There is a long history demonstrating that sulfur interferes with the performance of precious metal catalysts, whether they are on a vehicle or part of chemical or industrial processes, such as refineries.

11) *Has the EPA identified any new automotive technologies that can reasonably be expected to be deployed in the near term that would be impaired by current sulfur standards? If so, please provide a detailed list of the identified technologies.*

The performance of catalysts on every vehicle in the fleet today, as well as catalysts anticipated to be used on vehicles in the future, is reduced by sulfur even at current levels. There may also be introduction of other technologies (e.g., lean-burn gasoline direct injection) that would need lower-sulfur fuel to function as intended.

12) *Were the Tier 2 standards in place today for vehicles and gasoline quality established in conjunction with one another? Due to this process, was gasoline sulfur reduced for successful design and operation of Tier 2 vehicles? What conditions have changed that lead the Agency to believe that Tier 2 vehicles are no longer performing properly with Tier 2 fuels?*

Today's Tier 2 vehicle emissions and gasoline sulfur standards were established in conjunction with each other as part of a "systems approach" to reducing vehicle emissions. Lowering gasoline sulfur improved the efficiency of catalysts and enabled vehicle manufacturers to achieve the much lower emissions required by the Tier 2 standards. At the time these standards were finalized, there was not sufficient data on vehicle operation and emission performance below 30 ppm sulfur. Since that time, data has been collected to show that catalyst efficiency would be significantly improved with even lower sulfur levels, including for Tier 2 vehicles.

13) *Has the EPA calculated the up-front and recurring costs of such a regulation? Has the EPA calculated how these costs would impact fuel prices?*

This analysis is in the process of being developed as part of the Tier 3 proposal.

14) What are the fuel supply impacts from reducing sulfur in gasoline? What are the fuel supply impacts from reducing vapor pressure?

An analysis of fuel controls is in the process of being developed as part of the Tier 3 proposal.

15) Do other available markets exist for the light end products (e.g., butane & pentanes) that could no longer be used in gasoline blending due to the further reduction of sulfur?

Sulfur control would have little or no impact on the allowable concentration of butanes and pentanes that could be present in gasoline, but any impacts will be assessed as part of the Tier 3 proposal.

More energy intensive refinery process can increase refinery GHG emissions. Has the EPA considered how Tier 3 regulation would impact refinery emissions?

a) Does the EPA plan to credit refiners GHG requirements to offset new Tier 3 requirements?

b) If not, what impact will this regulation have on the competitiveness of U.S. refiners?

The EPA recognizes that more intensive refinery processing can increase refinery GHG emissions per barrel of product. We are assessing the likely effects on refinery GHG emissions of the Tier 3 fuel specifications that we have under consideration. While it is possible that GHG emission increases caused by changes in refinery configuration or operation will create the need for permits under the Clean Air Act Prevention of Significant Deterioration (PSD) program, we believe this will not be the case for most refineries. We will present our assessment of Tier 3 refinery GHG impacts and permitting issues for public comment as part of our proposal.

16) Is the EPA taking U.S. energy security into consideration in developing a Tier 3 rule? Could this rule result in reduced supply, increased imports, refinery closures, or any combination thereof?

The EPA is considering U.S. energy security in its development of the Tier 3 proposal.

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